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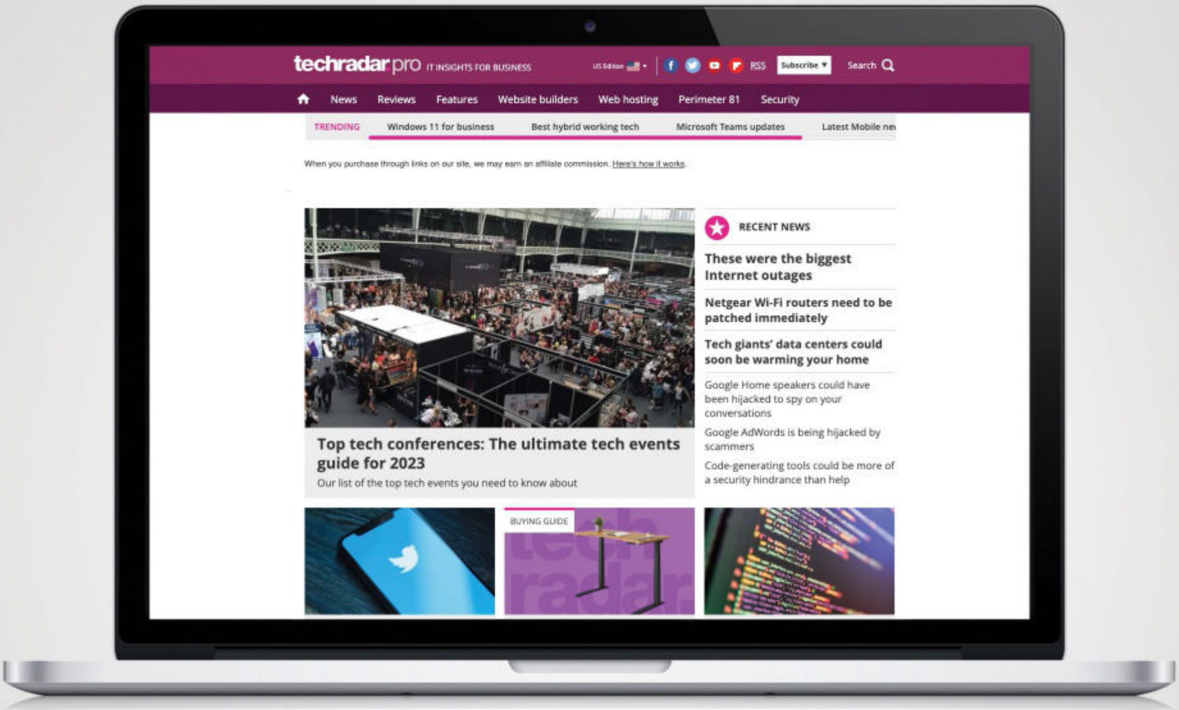

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Guy
Cocker

THE DO-IT-ALL PC

AS WE COVER in this issue's news (page 8), both AMD and Nvidia are now starting to release their mainstream GPUs, by which I mean the ones an average person might actually be able to afford. Yes, the last couple of years of having to pay four figures for a graphics card looks like it's coming to an end. But not everyone's happy, as our columnist Jeremy Laird points out this month in his Trade Chat on page 13, with his critical eye aimed particularly at the 4060 cards from Nvidia, which may start at $300, but still don't offer great value compared to their predecessors.

On the day I'm writing this, Nvidia has just become the first US chip maker to top a $1tn valuation. This came off the back of an earnings report that forecasted huge growth in the company's AI division, driving the stock up more than 25 percent in a day. With record profits driven in part thanks to pricey GPUs, I think it's doubtful we'll see Nvidia changing course, and we may be in an era where technological gains lessen while prices get higher. Perhaps more worrying, with so much money to be made out of the AI sector, will Nvidia's focus go elsewhere? Either way, it's probably not good for GPU consumers.

To look on the bright side though, with more affordable GPUs becoming available, we thought it would be a good time to build a "Do It All" PC for under $2,500. This is the sort of computer that you can put together and be confident of it lasting for years. We used Nvidia's new RTX 4070 to handle the graphics, which can comfortably power a 1440p display, and an i7-13700K as our CPU, which will tear through even the most demanding of computational tasks. Our builder, Sam, also kitted the machine out with a brand new NZXT Kraken cooler, DDR5 RAM, and modular 1000W power supply, meaning it's rocking the latest tech, and is ready to go whenever you fancy a GPU upgrade.

We're keen to hear what else you'd like to see from our future cover PCs. Next month, we hope to bring you a compact build, which will show those of you who value a small footprint how to make an ITX machine of your own. We're also looking at the latest generation of water-cooling kits for those who want to go all-out on silently cooling a top-of-the-line system. And don't forget, Sam and I discuss the making of our cover builds every month in our "Story of the Build" videos, which you can check out this month on page 17.

The rest of this issue is packed full of great stuff. We've reviewed the new Intel Core i3-13100F to see if this $110 chip is as good value as its predecssor. With AI grabbing the headlines, including ours on pages 9 and 10, we've got a head-to-head between ChatGPT, which is about to invade Microsoft's Edge browser, and Google's Bard equivalent. We also tell you how to streamline Windows for those of you whose operating system may have become a sluggish over time, as well as how to stay invisible online, for anyone who's tired of having their data used and abused.

On a personal note, I'm looking forward to getting my hands on the Asus ROG Ally, which we've featured in this month's Centerfold (page 50). Will it replace the Steam Deck as the best portable gaming machine? Come back next month to find out in our review.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's Editor-in-Chief. He built his first gaming PC in 1997 to play Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

AMD and Nvidia go Mid-range

Radeon RX 7600 and GeForce RTX 4060 fight for 1080p

AFTER WHAT feels like an interminable wait for new affordable graphics cards, AMD has released the Radeon RX 7600, while Nvidia has unveiled the RTX 4060 series. The Radeon RX 7600 is aimed at 1080p gaming, and brings us an RDNA 3 GPU at $269 for the reference card. It had been expected to launch at $299, but then Nvidia announced its RTX 4060 would be $299. This was lower than rumored, so AMD shaved $30 off the price.

At $269, we now have a properly affordable RDNA 3 card.

© AMD

At its heart, the 7600 runs a Navi 33 GPU with 32 compute units, 2,048 shaders, 32 ray tracing units, and 64 AI cores. It has a game frequency of 2,250MHz, a maximum boost of 2,625MHz, 8GB of GDDR6 memory, and 32MB of Infinity Cache. There's a 128-bit data bus, giving a memory bandwidth of 'up to' 288GB/s. This is directly comparable with the last generation RX 6650 XT, as it has the same core count. However, the 7600 is better at math, managing nearly twice the number of 32 and 64-bit operations. It has a power consumption of 180 Watts, drawing 165W, supplied by one 8-pin power connector.

AMD supplied some example frame rates at 1080p. The card will apparently run *Hogwarts Legacy* at 82fps, *Fortnite* at 125fps, and *Modern Warfare 2* at 108fps. Tests from early samples were not startling, but it is faster than the previous generation's RX 6650 XT. Ray tracing at 1080p is fine, with *Shadow Of The Tomb Raider* running in the 70s: a jump over RDNA 2.

Over at Nvidia, we have the RTX 4060 family ready. The 16GB RTX 4060 Ti is at the top with a price of $499, while 8GB is $399. Below these is the RTX 4060 at $299. The 4060 Ti has 4,352 CUDA cores, and a maximum boost clock of 2,540MHz, while the 4060 has fewer cores at 3,072, but a similar maximum clock of 2,460MHz. Both have fewer cores than the older generation 3060s.

The first card people could get hold of was the 8GB 4060 Ti. This isn't cheap, and you might expect to venture into decent 1440p gaming with it. It struggles to beat a 3060 Ti. If you drop to 1080p, it does better than the previous generation, but the margin is slim. Switching to ray tracing restores its supremacy with a lead of around 18 percent. However, if you crank up the dial to 1440p or 4K, that shrinks. Nvidia supplied its own benchmarks. This at least proves that the card can do a good job in certain conditions. In more general use, this isn't much of an upgrade over the 3060 Ti. Much of the blame is laid at the door of the memory bus, which is 128-bits wide, as opposed to the 3060 Ti's 256-bit bus. We've yet to see serious appraisals of the RTX 4060, but given that AMD felt obliged to undercut its $299 price, we can assume it matches it, at least. The competition between the RTX 4060 and RX 7600 will be acute.

Meanwhile, Intel has cut the price of its Arc A750 to $199 in selected outlets. The 8GB A750 card launched at $289, then dropped to $249, and is now under $200. Nvidia and AMD aim at the top, releasing headline-grabbing halo cards to showcase their new GPUs, then cut down their designs to make cheaper cards. Intel did things the other way, and the first Arc cards were barely passable low-end offerings with drivers that were nowhere near ready. Things have improved—now we have properly functional drivers and faster cards, albeit at a relatively low level. It took a while, but this is a sweet deal.

AMD estimates that 65 percent of gaming still takes place at 1080p. 1440p may be a better proposition for serious gaming while still being relatively affordable, but 1080p works well enough. Once you can play a game with most of the options ticked, and at a frame rate that looks good, other factors can be compelling. AMD and Nvidia have their fans, but few things make people switch brands faster than saving money. The choice always used to be between green and red. Blue now also appears to be a serious option. **–CL**

> “
> Nvidia and AMD aim at the top, releasing headline-grabbing halo cards

METEOR LAKE

LATEST ON THE NEW PROCESSOR

INTEL'S 14TH GENERATION CHIPS are due this fall, but the company is being recalcitrant over Meteor Lake. Like the 11th generation Tiger Lake, it's to be focused on the mobile market. It will also be the first to use new branding, as Core Ultra. The first sign of this has appeared on an engineering sample in a database listed as a Core Ultra 7 1003H—Intel is dropping the 'i', and adding 'Ultra'. What the other number means is another matter. We know that all Meteor Lake chips are to get dedicated AI hardware in the form of a Movidius VPU, a Vision Processing Unit that previously appeared on a few 13th generation chips. Are we getting Meteor Lake desktop chips? The latest rumor is that no, we won't. A leaked slide from a road-map shows that the main suspect as a desktop version, a 6P+8E core variant, has been dropped. **–CL**

WINDOWS GETS A COPILOT

Microsoft is making use of the AI advance

CHATGPT IS IN BING, and now Microsoft is busy adding AI Copilots to everything. This is to include Windows itself with the Copilot AI assistant, which integrates AI functions into the desktop and your applications. Want a document summarized or rewritten? Drag and drop it into Copilot. A Microsoft demonstration shows it being asked 'how can I adjust my system to get work done?', Copilot then suggests a few options, and provides links so you can select them without delving into Settings. Ask for a Spotify playlist, and it'll generate a selection. More complex jobs can be automated too, opening applications for specified tasks, then sending the result to a contact list, all through text prompts. It will, apparently, "change how you use your PC forever" according to Microsoft CEO Satya Nadella. Copilot will be available for preview in June. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **MASSIVE MONITOR**
Chinese tech giant BOE has built a prototype 16K monitor, with a resolution of 15,360 by 8,640.

✓ **DOS WARRIOR**
The Hong-Kong manufacturer Xinrui has launched a $200 laptop that runs an Intel 8088 and MS-DOS 6.22.

✓ **HIDDEN CITIES**
Archaeologists have used lidar to find over 400 hidden settlements in Guatemala's jungles, plus a network of roads.

TRAGEDIES

✗ **WORLDWIDE FAIL**
An expired security certificate caused every Surface X camera to stop working on 23 May.

✗ **AIRBORNE FIRES**
A 42 percent increase in lithium-ion battery fires on US planes has the FAA worried as onboard devices proliferates.

✗ **MYSTERIOUS PATCH**
Intel has released a microcode patch for almost every chip since 2017. Intel hasn't said why, but something was vulnerable.

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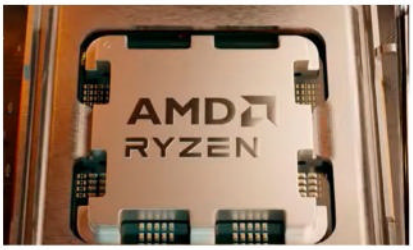
AMD CONFIRMS HYBRID CHIPS

Pheonix 2 APU to get Zen 4C cores

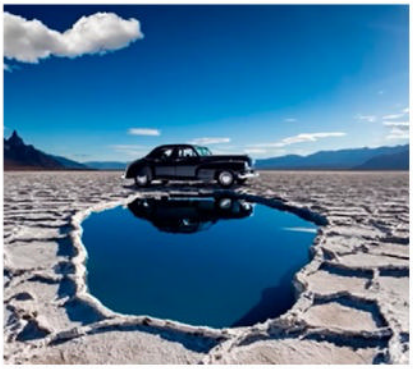
WE KNEW AMD was going to go hybrid—it's the obvious next step in processor development that Intel and Apple have already made. We now have confirmation from AMD's Chief Technology Officer, Mark Papermaster. AMD has done well with its tactic of throwing as many cores at a processor as it can. The Zen core was good, but it was the Zen 2 with its 16 cores that lit a fire under Intel, which has since staged a comeback with its hybrid big.little designs of Alder Lake and Raptor Lake.

The Phoenix 2 APU is expected to be the first application of a hybrid design, with two performance cores and four efficiency cores. Unlike Intel, AMD will use the Zen 4 architecture for both the efficiency and performance cores. The former, dubbed Zen 4C, will have less cache, slower clocks, and a profile tuned for low-power applications. Mobile application are where hybrid designs can count, and the Steam Deck 2 is already on board. AMD has also said it won't be dropping the big 16 core desktop processors. Zen 5 is expected to retain the basic outline of the Zen 4, but switching to a 3nm process from 5nm.

AMD is doing well at the moment, with its market share of the x86 market creeping up since Zen first appeared in 2017. It had around 20 percent of the desktop market, a long way from the heights of 2005, when it briefly managed parity in the desktop market. In the first quarter of 2023, AMD has pulled back to 34.6 percent of the x86 processor market, according to Mercury Research. Before Team Red aficionados get too exited, that includes embedded applications, where AMD's efforts have been rewarded. The PlayStation and Xbox both run AMD silicon, for a start. If these are taken out of the equation then AMD has 17.2 percent—still respectable, but matching or getting close to toppling Intel remains a massive undertaking. **–CL**



AMD's market share continues to be on the rise.



PHOTOSHOP GOES AI

Just type in what you want to see

ARTIFICIAL INTELLIGENCE has moved front and center with dizzying rapidity. Adobe is going all-in with a new generative AI fill engine called Firefly, which has been trained on a mass of Adobe stock and public domain images. If you've seen what Dall-E is capable of, you'll understand why this is a such a powerful tool. You simply select an area or object and use a text prompt to describe what you want. A demonstration shows the phrase 'classic car from the 50s' producing just that. The images match the lighting, perspective, and even add reflections. The generated images are created in a new layer, so you can experiment non-destructively.

How much do you need to change before it becomes 'your' image? Can AI-generated art ever belong to anybody? The US Copyright Office has released a new set of guidelines that help define what human authorship requires, but it's still a fuzzy area. A recent AI comic, for example, was granted copyright for the complete work, but not the individual images.

Firefly has a few quirks. Currently, every pixel is generated with no transparency, so if you want to add glasses to a face, the eyes get replaced too. Some selective editing with layer masks can correct much of this, though. Faces do look a little plastic, and some goofy results can be generated if there's too much for the AI to do. The biggest drawback is that Firefly can only generate images up to 1080 pixels in either direction. You can split your selection into slices, so for backgrounds this works well, but it isn't so useful if you want to add a complete element. However, Firefly will only improve, as this is just the beta. This phrase is rapidly being over-used with AI, but if you use Photoshop then Firefly earns it: this changes everything. **–CL**

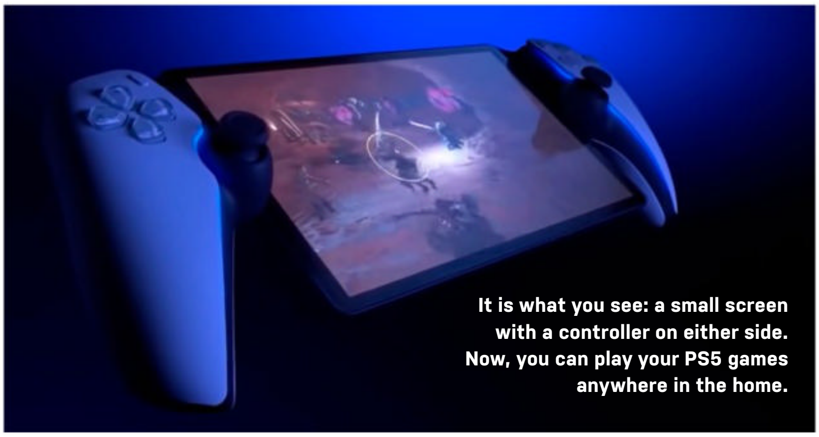
New Sony Handheld

SONY HAS A NEW HANDHELD, currently known internally as Project Q. It looks, essentially, like an 8-inch LCD 1080p tablet with half of a PS5 DualSense controller attached to either side. It enables you to play games streamed from your PlayStation 5 via Wi-Fi, so you have access to your full library whenever you're in range of your Wi-Fi. You'll need a strong signal, as there's data to shift, plus at least 5Mbps of bandwidth, although 15Mbps is recommended for a "better play experience".

The game needs to be installed on your PS5. Project Q may stream, but there's not a cloud in sight. It is not a traditional gaming handheld either, as there are no games stored on it. There are other remote play devices, but they can be awkward to set up. Keeping it in the Sony family should make this a painless proposition.

We have no hints of a price. A controller is about $70, and the high-end DualSense Edge is $199. Given the lack of cloud hardware needed or OLED screen, it should be competitive, and it'll need to be, as this is essentially an accessory. Sony spent $380 million buying the Gaikai streaming platform in 2012, then did little with it.

Gaming is shifting towards the cloud, but Sony so far seems reluctant to follow. The success of the Nintendo Switch proved that people do love their handheld gaming though, and Project Q puts all the power of your PS5 into your hand. It may not be cutting-edge technology, but it does look like good fun. The launch is expected in time for the holiday season. **–CL**



It is what you see: a small screen with a controller on either side. Now, you can play your PS5 games anywhere in the home.

PCIe 5.0 SSDs Run Hot

Users of the first generation of PCIe 5.0 solid state drives are discovering that these need proper cooling. The previous generation was happy with a passive heatsink at most, but doubling the data rates is putting too much heat into the chips. Running too hot means thermal throttling, cutting performance severely. Putting on too much pressure can lead to the SSD shutting down altogether, potentially resulting in data loss. Corsair and others will sell you naked SSDs, but the advice is that you will need to fit a chunky heatsink, and make sure there's a fan running. One advantage of SSDs has always been their silent operation, but with PCIe 5.0 that's no longer advisable. **–CL**

GPU Clock Record

Nvidia's 4090 is the world's best consumer GPU. Now, we have another world record: the highest clocked GPU to run a 3D benchmark. It was set by a overclocker called Cens, who tweaked the chip to run at 3.825GHz. The graphics card was a Colorful RTX 4090 iGame LAB, a limited edition card that has rigorously binned GPUs to find the most robust. It also earned top ranking in the 8K optimized list for Superposition, scoring 18,701. Ampere GPUs would struggle to reach 3GHz, while Ada Lovelace has proved more amenable to high frequencies, which bodes well for Blackwell, the next generation due in 2024. 4GHz is getting tantalizingly close. **–CL**

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Jarred Walton

TECH TALK

How much VRAM do you really need?

THE PAST MONTH has seen the launch and announcement of several new graphics cards: AMD's RX 7600, Nvidia's RTX 4060, and the RTX 4060. The internet is on fire, with benchmarks at times showing "horrible" performance, and widespread complaints about 128-bit memory interfaces and insufficient VRAM.

These aren't without foundation. We first started seeing high-end graphics cards with 8GB of memory in 2013 with AMD's R9 290/290X. Nvidia's GTX 1070 and 1080 had 8GB as well in 2016, starting at $379 for the base model 1070 cards. Seeing a $399 graphics card like the RTX 4060 Ti that still uses 8GB creates concerns that it will fall behind.

The problem is one of balanced design. It was probably two years ago when AMD and Nvidia began firming up specifications for these GPUs. By packing in more cache, the mainstream GPUs could get away with a 128-bit memory interface.

Nvidia says the 4060 Ti's 32MB cache is 52 percent more effective than the 4MB L2 cache on the previous generation RTX 3060 Ti. AMD says its 32MB Infinity Cache on the RX 7600 is 40 percent more effective than the RDNA 1 architecture. They're not lying. RDNA 2 proved even a 16MB cache (RX 6500 XT) could help, but effective memory bandwidth is only part of the equation.

With a 128-bit memory interface linked up to four 32-bit memory channels, these GPUs are limited to either 8GB or 16GB. Furthermore, to get to 16GB, they need two memory devices per channel. Both companies apparently decided that 8GB was enough for most people buying a $400 or less GPU.

Are they correct? That depends. AI workloads can consume a lot of memory, with some of the more modest LLMs (Large Language Models) requiring at least 20GB. That's why data center solutions like the Nvidia H100 NVL come with up to 94GB—and we could see 192GB variants in the future.

Gaming VRAM requirements can vary. The Xbox Series X has 10GB for graphics and 6GB for the OS and CPU. That means many cross-platform games will target 10GB or less for VRAM. High-resolution texture packs can move beyond that, but they're not as critical as many people think. That's because of mipmapping.

Mipmaps are used to store multiple copies of a texture at various resolutions. Which texture is used depends on how many pixels it covers. Considering many objects will only cover a relatively small part of the screen, 1024x1024 textures are generally sufficient—even at 4K, the difference between 2K and 1K resolution textures is usually insignificant. But the high-res options can still get selected, and on a 4K monitor, they're more likely to be used, which is partly why 4K gaming hits cards with 8GB harder than 1440p.

It also depends on the game engine and how it handles texture management. Numerous games in the past six months have pushed beyond 8GB of VRAM use, and with on-the-fly texture streaming, you can get situations where a game will swap between low-res and high-res textures. It can look ugly, and lots of games have proven that this isn't necessary.

We would have been happier if Nvidia opted for a 192-bit interface and 12GB on the 4060-class GPUs, then 256-bit and 16GB on the 4070-class, and 320-bit with 20GB on the 4080-class. That appears to be where AMD is heading on its RX 7000-series. Unfortunately, Nvidia decided to cut costs and bus widths. It argues that 8GB will still be sufficient for 1080p gaming, and it mostly is—for now. But don't be surprised if 8GB cards age poorly in the coming years.

The top AMD RX 7900 XTX and Nvidia RTX 4090 max out at 24GB of VRAM right now, while mainstream cards are still using just 8GB.

RTX 4090
RADEON

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE BEST VR HEADSETS

IN 2023, a VR headset needs to be immersive, comfortable, and offer support for a wide selection of games and apps. It should also offer good value for money, whether you're spending hundreds or thousands of dollars. Luckily, there are many excellent VR headsets that fit that description today. We've rounded up all the popular models from Valve, Meta, HTC, and the rest, and tested them to death so you can decide which one is worth your hard-earned cash.

5

META QUEST PRO

Although Meta's top-end VR headset is expensive, it recently dropped from its launch price of $1,500 down to $999. The Meta Quest Pro is impressive, but its short battery life, the decision to have it focus on mixed reality, and underused features mean our number one pick will be better for most people. However, the controllers are excellent, eye tracking has potential, and it's supremely comfortable to wear. **$999, www.meta.com**

4

HP REVERB G2

The HP Reverb G2 has a place here thanks to its fantastic resolution of 2160p per eye, provided you have a powerful enough GPU to handle it. It needs no base stations, which means a simpler setup, but there's no finger-tracking like on Valve's Index. Visible light tracking also means conditions can affect your experience—don't expect it to work well in a Sunroom or in the dark. **$599, www.hp.com**

3

HTC VIVE PRO 2

The HTC Vive Pro 2 has an incredible native resolution of 2,448 x 2,448 pixels per eye, and when coupled with the 120Hz refresh rate and 120-degree field of view, it makes for one of the best viewing experiences around. The only downside is tha need a high-end PC to use it. It's comfortable to wear, and if you want an untethered experience, it's also compatible with the HTC Vive wireless adapter. **$999, www.htc.com**

2

VALVE INDEX

This boasts some of the best visuals of any available VR headset, and that's down to the brilliant RGB LCD screens. It feels great to wear thanks to the built-in near-field speakers, which hover next to your ears. Proper finger tracking is another cool feature. **$999, store.steampowered.com/valveindex**

1

META QUEST 2

The Quest 3 has just been announced, but for now, this is the best VR headset. At 1,832 x 1,920 resolution per eye, the Quest 2 offers exceptional clarity for the price of an entry-level headset. But it wins for its versatility, as you can either play games purpose-built for the headset, or beamed from your PC using Oculus Link and a USB Type-C cable. **$399, www.meta.com**

© META, HP, HIVE, VALVE

Jeremy Laird

TRADE CHAT

What is actually going on with gaming graphics?

AMD AND NVIDIA have launched their latest GPUs to near universal derision. AMD's new Radeon RX 7600 was met with apathy, and Nvidia's GeForce RTX 4060 Ti took a beating. Why has this new generation of GPUs been so disastrous, and is anything going to happen to turn it all around?

There's nothing fundamentally wrong with this generation of graphics. The RDNA 3 architecture probably hasn't met AMD's expectations, but it's far from a trainwreck in technological terms.

As for Nvidia's Ada Lovelace GPU architecture, actually it's fantastic. The RTX 4090 delivers around 60 to 70 percent more performance than its predecessor, the RTX 3090, which itself was monstrously powerful. Had that generational performance boost extended down through the rest of the RTX 40 family, which now comprises five GPUs with the addition of the RTX 4060 Ti, we'd have one of the best GPU architectures ever.

But that hasn't happened. In fact, with each successive launch, the RTX 40 series has looked worse. The RTX 4080 offers a decent boost over the RTX 3080, but at a huge price premium. As you move down through the RTX 4070 Ti and RTX 4070, the gains over the previous generation shrink.

By the time you get to the RTX 4060 Ti, you're looking at a 15 percent boost at best in performance over the RTX 3060 Ti. You don't even get any more VRAM than the old board, which will likely hobble performance in some games. Who wants to pay $399 for an 8GB GPU that's marketed as 1080p and probably won't deliver that in some games?

As for the AMD RX 7600, it may be cheaper than the RTX 4060 Ti at $299, but it's also slower and represents a similarly incremental improvement over the RX 6600. If AMD and Nvidia continue with these tiny generational performance improvements, it's going to take 10 years to double performance.

> Gaming graphics are gradually becoming a less important part of Nvidia's business

Both AMD and Nvidia are building their latest GPUs on TSMC's 5nm and 4nm nodes, and enjoying the density and efficiency benefits that brings. The problem isn't Moore's Law breaking down; it's Nvidia.

Nvidia's new RTX 4060 Ti is another price-to-performance dud

© NVIDIA

Gaming graphics are gradually becoming a less important part of its business. The company's most recent financial numbers showed a spike in revenues from GPUs sold for AI language model training, the so-called ChatGPT dividend.

At the same time, Nvidia got hooked on selling GPUs at a huge premium due to the now-defunct crypto mining craze and the once-in-a-generation demand spike caused by the pandemic. The company seems convinced that it can dictate GPU prices.

If you pushed most of the new RTX 40 family members down one tier, it would make sense. In other words, if the new RTX 4060 Ti was rebranded RTX 4060 and sold for $299 instead of $399, it would be okay. Then you'd rebrand the RTX 4070 as the RTX 4060 Ti and offer it for $399. That would be a nice card and nobody would complain.

As for AMD, it has too small a share of the market. Sure, it could price its RX 7900 XT at $599, but then the next batch would be marked up by retailers, and the recommended price would be academic. AMD doesn't manufacture enough GPUs to cover the bulk of the market, so it may as well mirror Nvidia's pricing and make big fat margins.

There are signs that Nvidia is beginning to grasp that this approach won't work. For sure, there are widespread reports that the 4060 Ti is selling badly, but this is going to be a long-term fix, not an overnight solution. It's looking like this is going to be the lost generation of GPUs, overpriced and irrelevant to most gamers.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

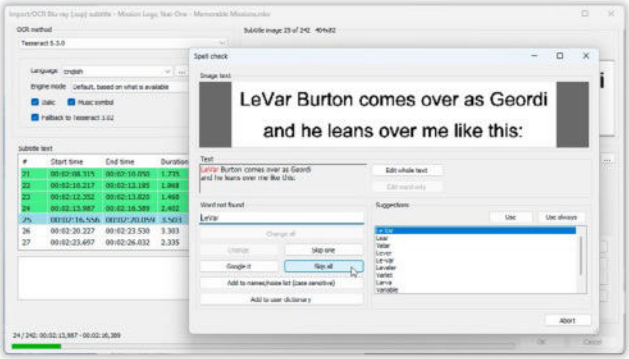
> Media subtitles editor
> Combine security tools
> Play classic games

Burning subtitle question

I followed your guide to media streaming, but am frustrated at having to download subtitles for HD movies in Jellyfin rather than use the embedded subtitle track. I know of a program for the Mac called Subler, which automatically converts image-based subtitles into a text-based format that's compatible with the MP4 container. Is there a Windows equivalent that can do this job for me?

—George Hilton

THE DOCTOR RESPONDS: Sadly, despite the Doc's best efforts, he's yet to find an alternative to Subler on the Windows platform. However, if you're willing to put in a bit more effort, then it is possible to achieve what you want. You'll need to output your file in Handbrake using the MKV container, which preserves the subtitle format without embedding it into the picture. From here you'll need two further tools: SubtitleEdit (www.nikse.dk) to convert the subtitle track to a text-based one using OCR, and then BOX4 (www.videohelp.com/software/BOX4) to remux the MKV file to MP4.



LeVar Burton comes over as Geordi
and he leans over me like this:

Convert image-based subtitles to text with SubtitleEdit.

Open SubtitleEdit and choose 'File > Import > Subtitle from video file' to select your MKV file. When prompted, click Yes to download the latest version of Tesseract OCR, followed by Download to get the OCR dictionary you need—you'll only need to do this once.

Once done, an Import dialog will open revealing the very first subtitle as an image file. Leave the default settings selected and click 'Start OCR'. Subtitle Edit will go through the subtitles line by line—if it comes up against an unrecognized word, you'll be prompted to check, just like with any regular spellcheck. You can accept or change the word as required, plus add it to the dictionary to prevent it being flagged in future.

Once complete, click OK, followed by 'File > Save' to save the subtitles in .srt format. Next, open BOX4 and click Settings. Check the first two boxes ('By default, always enable 'FastStart'... and 'Passthrough (Copy) Audio...') under Options. Make sure 'Track Selection' is set to 'All' under 'Default Audio Track Selection'. Click Profiles, then the Matroska button under Profile to set MP4 as the default file format, then click Close.

Now, click File to select your MKV file. You should see the input file listed above the proposed output file (basically the input file with an MP4 file extension)—click this to change the filename or folder location. To the right you'll see two banks of numbers—the top row lists how many audio tracks there are (those listed in green), while the bottom bank lists the subtitle tracks. Here, you should see that the number 1 is listed in red, indicating that the image-based track isn't compatible with MP4, so will be dropped from the file. Click the 02 next to this, and a dialog will open—select the .srt file you created in SubtitleEdit, and the number 02 will change to green.

Once you're happy, click the Start button and wait while the file is remuxed, which you'll notice is a far quicker job than the original conversion. The resulting MP4 file is now ready to be added to your collection.

Which security tool?

In your Feb 2023 issue, you had an article about using Microsoft Safety Scanner. I use Malwarebytes Premium as my primary antimalware/antivirus software, and then run Microsoft Defender as a backup every month or so.

To do this, I must manually turn it on to run one of four scans: Quick, Full, Customized, and Offline Scan

© SUBTITLEEDIT/ BOX4

↘ submit your questions to: doctor@maximumpc.com (which you say isn't present in Safety Scanner). After the offline scan is done, it returns me to my desktop, and I turn my computer off. The next time my PC is switched on, Defender is turned off automatically, and remains so until I switch it on to run the next manual scan.

Is there a way to do a more thorough scan of my computer than what Defender or Safety Scanner offers? Does Windows automatically download the most current definitions when Defender is turned on? Since I am turning Defender on and then running scans does it know to download the most current definitions before it runs them? I have been doing this since I first installed Windows 10 and Malwarebytes without any known virus/malware attacks being successful. I do have Secure Boot on. **—Dakota Red**

THE DOCTOR RESPONDS: As Nik Rawlinson's original article implied, Safety Scanner is more of a tool to be used when you suspect your PC has been infected, despite what your primary security tool says, so it's no replacement for Microsoft Defender. However, while it's generally considered good practice to only run one security tool at a time, Malwarebytes Premium is a slightly different beast in that in its own words, "Malwarebytes for Windows is designed to coexist with other antivirus software". This means you can install both it and another tool together and run both with real-time protection enabled. As proof of concept, the Doc has successfully run Malwarebytes with its real-time protection engine enabled alongside Bitdefender for the past few years with no problems, although there will be a performance hit on slower machines.

Your best approach is to enable Microsoft Defender's real-time protection and see how it performs. You should have few—if any—problems, but there may be times when the other antimalware tool incorrectly identifies Malwarebytes as a threat. In this case, you'd need to whitelist the following Malwarebytes files, folders, and hosts in your other security tool:

Folders: C:\Program Files\Malwarebytes, C:\ProgramData\Malwarebytes

Files (all found within C:\Windows\System32\drivers\): mwac.sys, mbamswissarmy.sys, mbamchameleon.sys, farflt.sys, and mbae64.sys (mbae.sys on 32-bit machines)

Hosts: keystone.mwbsys.com and sirius.mwbsys.com

This shouldn't be an issue in Defender. Going forward, if you'd still like to perform monthly scans with another tool for additional peace of mind, the Doc recommends the free Emsisoft Emergency Kit (www.emsisoft.com/en/home/emergency-kit/), which you can run from a USB stick—simply update the signatures before scanning.

Retro emulation question

I'm feeling all nostalgic for my old 80s and 90s computers and consoles. I see most can be emulated, but wondered if there's some way I can bring them all together under one roof, so to speak. Is there a recommended spec or platform that allows me to encompass all my favorite games within a single location? **—Graham Headway**

THE DOCTOR RESPONDS: In the past, if you could have restricted yourself to 8-bit and 16-bit machines, say no later than the Atari ST or Commodore Amiga, then the Doc would have recommended a dedicated machine in the form of a Raspberry Pi 3B or 3B+ and the RetroPie (https://retropie.org.uk/). The lack of RPi stock make this a non-starter, however.

Instead, you can incorporate your legacy gaming into your current PC, as it'll be able to handle anything from 20+ years ago. A popular choice is RetroArch (https://retroarch.com), which is designed to bring together a wide selection of emulators under one roof. That said, it's a little fiddly to set up, so consider another frontend (one, which ironically uses RetroArch) that's even easier to use. LaunchBox (www.launchbox-app.com) is the program in question—just import your games, select the platform, and let it do the rest. It's available in both free and paid-for versions, but for most, the free version should suffice.

UFS data recovery

Long-time subscriber here. I'm in a kerfuffle of my own doing. I've been running XigmaNas in a VirtualBox virtual machine on a Windows 10 host with 2TB spinning disk. The drive was accessed using VirtualBox's raw hard disk access using a UFS partition.

The VM developed an issue and wouldn't boot. My attempts to fix it did nothing, so I spun up another XigmaNas VM and attempted to connect the drive/partition to that VM. I made a slew of mistakes trying to get the drive to be recognized by the VM, and ended up accidentally formatting it again as UFS. Once I realized my error, I set about trying to run various recovery software to recover the data. I am sure the data is there because the format took just three seconds to complete, so obviously was a quick format.

I've tried the following tools from the Windows 10 host, as usually specified by instructions: Hetman Linux Recovery, Hetman Partition Recovery, UFS Explorer Standard Recovery, Disk Internals Partition Recovery, and Disk Internal Linux Recovery. I also tried one of these—Hetman I think—from a Linux Mint VM mounted there, which also failed to find what I'm looking for.

With all tools, I chose UFS as the filesystem to recover, but only a couple have identified the folder structure, and even then the folders are empty. Content-aware analysis is even worse with the junk it returns (after several hours running).

This drive was my non-mirror, so theoretically there is nothing critical on it, but I am a pack rat, and if I could recover it I would feel better. Any other suggestions on anything I can try? I am pretty much about to concede defeat and format the drive and move on, as it's become a time sink. **—Mac**

THE DOCTOR RESPONDS: Data recovery is always a case of shutting the barn doors after the horses have bolted, and we were unable to help Mac get any data back. We'd suggested two additional tools : R-Studio ($49.99, www.r-studio.com/), which claims to support what it describes as "Big Endian variants of UFS1/UFS2 (FreeBSD/OpenBSD/NetBSD/Solaris)", and as a last resort, DMDE (https://dmde.com/), a general purpose recovery tool that's free to use, but doesn't explicitly support UFS. R-Studio did detect four UFS partitions, but crashed trying to access two of them, while nothing was found on the other two; DMDE was unable to produce anything retrievable.

Mac admitted there was nothing of value on the drive, so definitely time to reformat and move on. We wonder if this might be a cautionary tale about pursuing XigmaNAS and XFS as an NAS-based solution. The lack of a simple, comprehensive image-based backup tool for protecting the drive's contents would be a dealbreaker for the Doc—this is why he chose Ubuntu Server to power his own NAS-based server...

BEST VALUE PC 2023

After a hard day's work, you deserve to kick back and relax with *Maximum PC's* best-of-both-worlds RTX 4070 for under $2,350

LIFE'S ALL ABOUT balance. Whether that means cracking on with some work during the day so that you can then enjoy some games in the evening, a good mix of both is needed to get the most out of life. Trust us, there's nothing we like more than to relax and immerse ourselves in a fantasy world after a hard day's graft.

With this build, we've focused on creating a great balance of components to provide you with a system equally capable of business and pleasure. Sure, a top-end system will also achieve this, but here in the real world, we thought it was important for this machine to land at around the mid-range price spot.

Our brain in the machine is Intel's Core i7-13700K. This is one impressive chip, and although it can get overlooked often in favor of the i9 range of processors, this 16-core i7 CPU should provide our system with plenty of zippy processing capability. We've chosen to put this alongside a solid RTX 4070 card, specifically Zotac's 12GB GAMING GeForce RTX 4070 Trinity. At $600, you're getting a lot of bang-for-buck performance with this card, which has been difficult to say about Nvidia's 4000 series so far. Working with the CPU, it should make a great duo for video editing, 3D modeling, and graphic design work, and it should absolutely blitz through Microsoft Word! Then, when all of your hard tasks throughout the day have been ticked off, and you're feeling on top of the world, this RTX 4070 card should be able to provide you with some smooth QHD gaming, and thanks to DLSS 3, even veer into the world of 4K (if you turn the presets down slightly).

We're fitting this all within an NZXT H7 Flow case, the best of the bunch from the H7 lineup in our opinion. It's a classy-looking case that also features excellent airflow. This should be able to keep our system running quieter, as the heat will be able to dissipate quicker than either the standard H7 or Elite, which don't feature as many aerated panels as this model. With some RGB software tweaks, a clean white and black color scheme will be able to show off both a professional side and a sleek gaming aesthetic. With all that being said, it's time to put this all to the test.

BENCHMARKS

Part		Price
Case	NZXT H7 Flow	$130
CPU	Intel Core i7-13700K	$400
CPU Cooler	NZXT Kraken Elite 360 RGB	$300
Motherboard	ASUS ROG STRIX Z690-E Gaming Wi-Fi ATX	$280
GPU	ZOTAC GAMING GeForce RTX 4070 TRINITY 12GB	$600
Memory	32GB (2x 16GB) XPG LANCER RGB DDR5 DDR5-6000MHz	$240
SSD	2TB XPG GAMMIX S70 Blade PCIe 4.0 NVMe SSD	$140
PSU	1000W Corsair RM1000x SHIFT 80 PLUS Gold Fully Modular ATX	$210
OS	Windows 11 Home 64-bit OEM	$32
Total		**$2,332**

PRICES CORRECT AT THE TIME OF PRINTING

https://content.jwplatform.com/videos/sYj0UZhB-u2lN49He.mp4
Please type this URL into your browser if link is broken

NZXT
26°
Liquid
XPG
ZOTAC
GEFORCE RTX
NZXT

BUILD IT!

Step-by-step guide to assembling this PC **PG. 22**

TAKING A DEEPER LOOK

CPU
Intel Core i7-13700K

It's our first time getting this CPU into a cover build, and boy oh boy are we excited. With so much love for the Intel Core i5-13600K, the i7-13700K adds two more cores to the mix, and takes the max turbo frequency from 5.10 GHz up to 5.40 GHz. It features the same hybrid architecture we've seen since the 12th generation of Intel chips, splitting its 16 cores in two. We have eight performance and eight efficient cores, as well as a total of 24 threads. This K variant also includes Intel's UHD Graphics 770 if you're GPU-less—luckily, we have the RTX 4070. At around the $400 mark, the i7-13700K is not a cheap processor. However, it should last for a long time, and have enough power for gaming and working.
$400, www.intel.com

BUILD IT!
Step-by-step guide to assembling this PC **PG. 22**

CPU Cooler
NZXT Kraken Elite 360 RGB

To help further with cooling, we went with the most premium release NZXT has to offer: their range-topping NZXT Kraken Elite 360 RGB. This is a new refresh of the Kraken line-up, and we've gone for the matte-white 360mm model to contrast against the black interior of our case. This cooler comes with a new pump header that features a 60Hz display at a 640x640 resolution. Overkill? Yes. Do we like it? Yes. Here, you can add custom GIFs and images, or show hardware monitoring like your GPU and CPU temps all through the NZXT CAM software. In the box, you get three F120 RGB Core fan which will provide the lighting to keep your machine glowing strong and running quietly.
$300, www.nzxt.com

PSU

1000W Corsair RM1000x SHIFT 80 PLUS Gold Fully Modular ATX

We may have gone slightly overkill here, but we're thinking of the future. This power supply is more than capable of powering an RTX 4090 let alone our RTX 4070. However, we thought we'd add one in here now for longevity purposes—if you need to upgrade your GPU down the line for added gaming performance you then wouldn't have to purchase another PSU. This RM1000x SHIFT is of course 1000W, it features an 80+ Gold efficiency rating, and is ATX 3.0 certified. One of our favorite features is the side connectors, making this far easier to build with. Instead of trying to feed cables through the back of the PSU in the bottom of the case, the side access is far easier.

$210, www.corsair.com

GPU

ZOTAC GAMING GeForce RTX 4070 TRINITY 12GB

We used the Ti version of this card in our March 2023 issue for the Intel NUC 13 Extreme system—this is the standard version 4070 variant. Yes, we've gone for the more affordable sibling to the 4070 Ti featured in the NUC to try and get some impressive performance while also saving a few dollars in the process. Our model can be picked up for $600, while the Ti is an extra $150—that's quite a difference. Despite having this price gap, you are also still getting NVIDIA DLSS 3 and full ray tracing support, 12GB of GDDR6 memory, and of course Nvidia's ultra-efficient Ada Lovelace architecture. That's not a bad package at all. This should make this card perfect for 1080P/QHD gaming and a powerhouse for graphically intensive work, too.

$600, www.zotac.com

Memory

32GB (2x 16GB) XPG LANCER RGB DDR5 DDR5-6000MHz

DDR5
XPG
DDR5

For both working and gaming, 32GB of RAM is still a healthy amount of memory. Especially running at 6000MHz, this kit from XPG is no slouch at all. To boost speeds, it supports Intel XMP3.0 for quick overclocking, too. With heavily intensive CPU tasks, the processor needs the RAM for more data, essentially making the RAM the bottleneck. Faster RAM speeds will definitely help the performance in these scenarios. As well as being fast and dependable, it looks pretty great too with RGB. Throughout the day at work, you can have this set to a subtle lighting theme, then when you want to game, crank up the lighting settings for some rainbow madness. It's the best of both worlds.
$240, www.xpg.com

Case

NZXT H7 Flow

When we reviewed all three of the H7 cases from NZXT, this one stood out above the rest, offering the best performance and value for money. With an aerated front and top panel, it does exactly what it says on the tin. We need our system to stay cool to keep the fans quiet, as this will help us when working, designing, or creating on this system, so we need as much air as possible to enter and exit the case. As well as being efficient, it looks the part too, and has a fantastic build quality. Cable management has been a strong point for NZXT's recent cases as well, with plenty of channels and routing options. Oh, and did we mention that you don't need any tools to take off the main panels here? That certainly helped us out quite a bit!
$130, www.nzxt.com

Motherboard

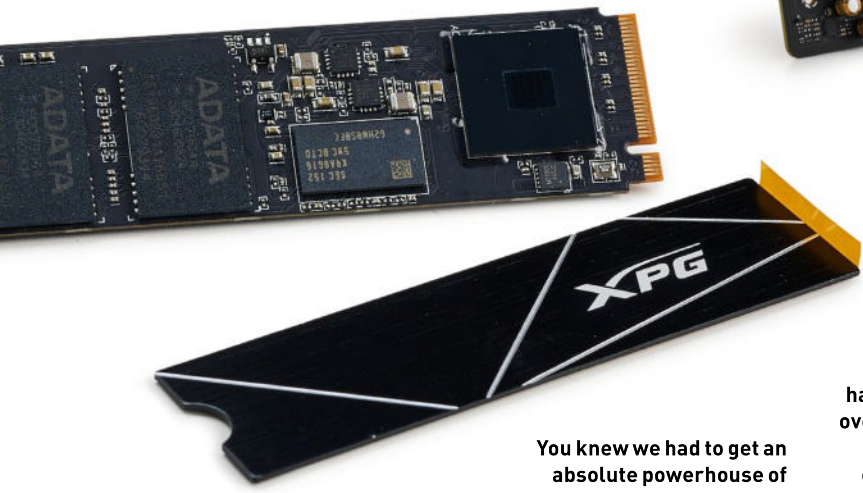
ASUS ROG STRIX Z690-E Gaming Wi-Fi ATX

Connecting all of the dots in this machine is our ASUS ROG STRIX Z690-E Gaming Wi-Fi ATX. Although technically not the latest and greatest chipset to pick from, this still perfectly supports our 13th gen Intel CPU with its LGA1700 socket, and is suitable for many more years of usage. It also supports DDR5 memory, so we can get much faster speeds with our RAM here. The ROG STRIX Z690-E Gaming Wi-Fi has plenty of ports, including 3 x M.2 slots, 3x PCIe slots, and an abundance of USB ports on the I/O panel. Cooling is another strong point, as this features a multitude of heatsinks over the M.2 ports, chipset, and a large integrated I/O & VRM heatsink. This is important, as we want to keep this build running quietly.

$280, www.asus.com

STRIX
ROG
STRIX Z690-E GAMING WIFI
14

BUILD IT!
Step-by-step guide to assembling this PC **PG. 22**



SSD

2TB XPG GAMMIX S70 Blade PCIe 4.0 NVMe

You knew we had to get an absolute powerhouse of an SSD in for this machine. 2TB of storage should be more than enough to install most of your favorite games and still have tons of storage left over for your work. What will certainly help us out with our workflow, productivity, and designing are the impressive speeds of the S70 Blade. With up to 7,400MB/s read speeds and write speeds of up to 6,800 MB/s, it's clearly a super-snappy SSD and for a primary drive, it's exactly what you'll need. It also comes with a very slim heatsink separately in the box, which is installed via a sticky-back adhesive.

$140, www.xpg.com

NZXT
24°
GEFORCE RTX

WORK HARD PLAY HARD

WILL THIS SYSTEM SUIT ALL OF YOUR NEEDS?

LENGTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

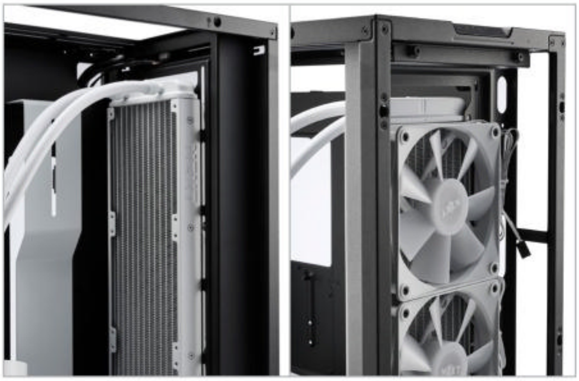
1 THE BONES OF THE BUILD

IT MAY SEEM a bit counterintuitive to remove parts from our build in the first step, but it's the way we like to do things around here. Trust us, it helps when space is tight in this chassis. Thankfully, NZXT cases are some of the easiest out there to take apart. In fact, this H7 flow requires zero tools to take all of the panels off. They all come off with a small amount of force, and getting them back on is just as easy. We started by taking off the front panel, which is done by putting your hand at the bottom and lifting up. Then this makes the top panel even easier to remove. Once they were gone (put safely to the side), we took off the glass panel and the back panel, and again, stored these somewhere safely.

At this stage, we also moved our front case fan to the top at the back. This is to make room for our NZXT cooler, which we'll be placing at the front. These case cans are held on by 4x Philips screws. To use this as an exhaust fan, we had the face of the fan facing inwards, in the process ensuring that the air will be sucked outwards.

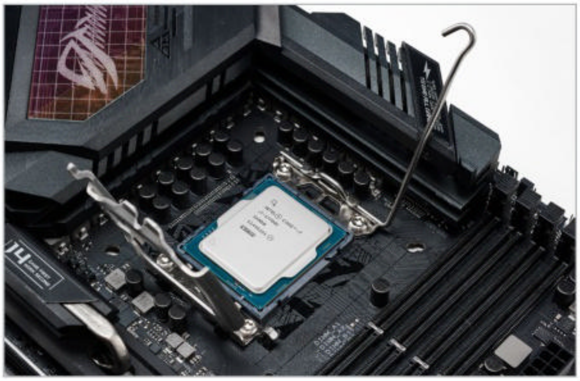
2 KEEPING IT COOL

CONTINUING ON with the cooling side of our system, we have something fun to play with: NZXT's new Kraken series, and we have the best of the bunch, the Kraken Elite 360 RGB. In white, this should contrast nicely against the internal black of the system. As we've removed our front fan, we now need to install the radiator and fans onto the front. To make life easier, lay down the case on its small back edge, where the motherboard I/O will go, then make sure the hoses are towards the top of the radiator, and hold this upwards while screwing the fans onto the other side of it. Use the long screws and washers to ensure a tight and even fitment. Also, make sure the cables are coming out towards the back so you can tuck these away later when cable managing.



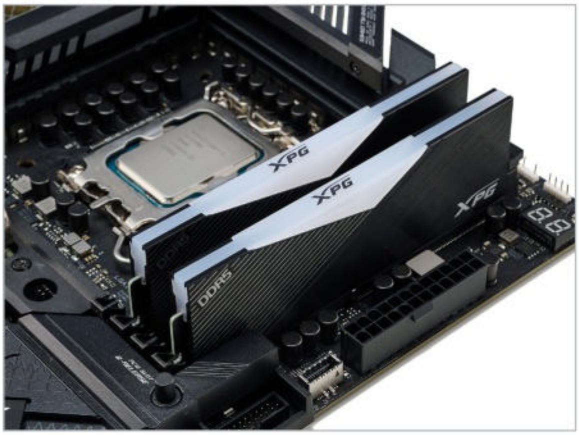
3 CASE ASIDE

WITH THE COOLING in place for now, it's time to turn our attention over to the brain of the build, the Core i7-13700K—this CPU needs a throne to sit on. Like all of the Intel CPUs after the release of the 12th gen chips, they are much easier to seat into the socket, as now it's 50/50 whether you've got it in the right way or not instead of a 25 percent chance with the older square models! Silliness aside, lift up the retention bar on the motherboard and open up the socket. Then, take your chip by the sides and match the golden arrow on the processor to the one on the motherboard socket. This will change your 50/50 odds to a 100 percent success rate of installing the processor in the right orientation. With it seated, lower the retention bar back down to lock it in place.



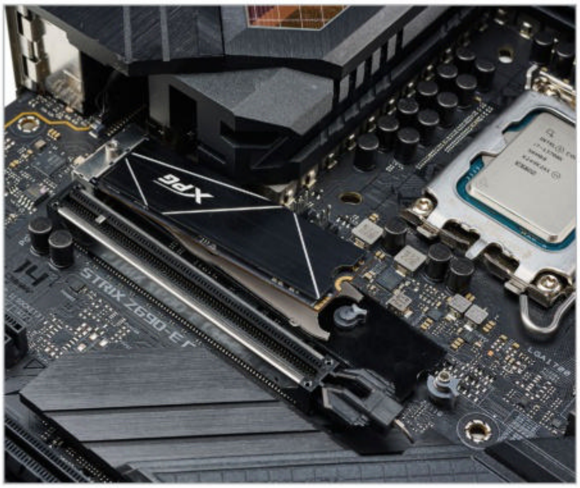
4 PESKY NEIGHBORS

RIGHT ALONGSIDE the CPU is where we need to install our RAM sticks and the DIMM slots. Now, as we have two, and there are four slots, it's essential to get these in the right order. Check the motherboard's official manufacturer support page or manual to find this out, but more typically than not, if you have two sticks they will go in slots 2 and 4. That was the case for us. To open these up, press on the clips above the slots. Then, take your RAM stick and align the notch on the stick with the notch in the DIMM slot. Once aligned, press down evenly, and this will click into position, closing the clip in the process. Not too bad, hey?



5 MORE PESKY NEIGHBORS

UNDERNEATH THE CPU is where our SSD will live (for now, anyway)! This 2TB drive will be enough to house some large design projects, plenty of games, and be speedy enough for lightning-fast file transfers. All you can ever ask for, right? Anyway, to get to our SSD slot, we must first remove the heatsink. This comprises two tiny Philips screws. Be careful when removing these, and make sure you keep them in a safe place, as you won't find these screws if they fall off your workbench. With the heatsink removed from the motherboard, we can now add the included slim heatsink that comes with our SSD onto the actual SSD itself. Just remove the thermal heat pad cover and place it on top. Then, we can add this onto the motherboard by placing the connector into the port and pushing it down into place. To secure it down, the motherboard has a twisty plastic screw preinstalled that you can spin around to latch onto the drive. Aftwerards, we can reinstall the original heatsink over our SSD. As the SSD's heatsink is so thin, this can still be used.



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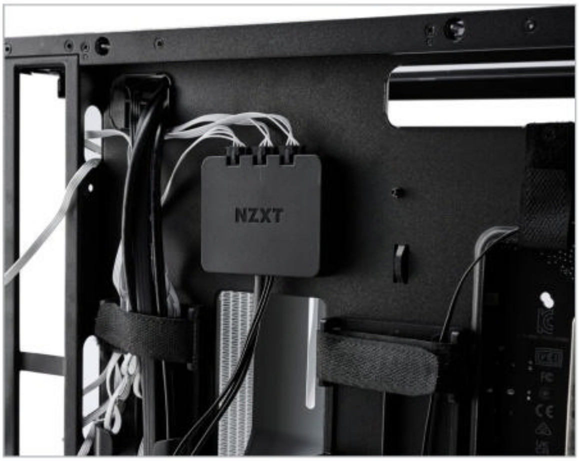
6 *IN YOU GO MOBO*

EXCEPT FOR OUR GPU and CPU pump header, all of our main components are now installed onto our motherboard, and this can be inserted into the case. Put the I/O port part of the mobo in first into the back of the case, then you can rest the board down onto the standoffs. To make this even easier, lay the case down flat first. We also recommend installing all necessary case screws into the board to maintain even pressure across the PCB and avoid any shorting. A long-necked magnetic screwdriver will save you a lot of hassle here too, as it's easy to drop a screw or two into the abyss of your PC case. If not, you'll be just like us, shaking your PC around until you eventually find said wretched screw!

7a *THE FAN CONTROLLER*

WE'RE NOW HEADING back to our system's main cooling solution, the Kraken Elite 360 RGB. To make sure the fans are working properly and light up as they should, we need to install the fan controller that came with the kit. Thankfully, this is very easy, and magnetizes to our case with no need for any sticky-back adhesives. To keep the RGB fans synchronized, we attached the top fan RGB cable into slot 1, then the middle into slot 2, and the bottom fan into slot 3 of the fan controller. The fan controller has a motherboard USB connector and a SATA lead for power.



7b *THE FAN CONTROLLER continued*

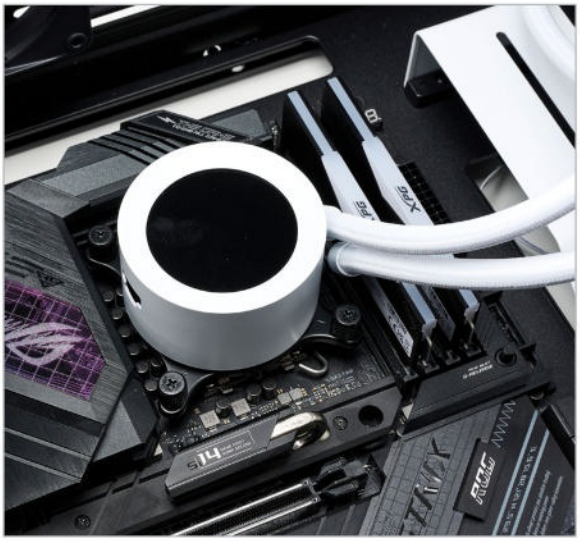
THE OTHER CABLES on the fans are there to power them up, and they will be attached to the daisy chain provided in the kit. This daisy chain is connected to another set of cables that will connect directly to the CPU pumper header—confused yet? It's actually easier now than NZXT's older models, and a quick glance in the manual will clarify any confusion here.

8a *CPU PUMP*

WE'RE NOW at the stage where we can start attaching the CPU pump to our motherboard. In the NZXT kit, you'll find a backplate and four Intel standoffs, which we need to attach before going any further. Attach the backplate from the back of the case so that the screw holes align, then take the standoffs and screw them into the motherboard and backplate.

8b CPU PUMP *continued*

MAKE SURE THAT the Intel LGA1700 bracket is installed onto the CPU pump—not the AMD one—and align the holes on the bracket with the standoffs. We've aligned ours so that the hoses come out of the right-hand side of the pump. With this in place, take the four thumbscrews from the Intel bracket set and secure this down, tightening diagonally in stages to achieve even pressure.



8c CPU PUMP *continued*

THE LAST STEP to do here is to turn back to that daisy chain cable from earlier, as one of the leads from that splitter goes into the CPU pump and another goes directly into the motherboard in the pump fan header. There is also another SATA lead here for power.

9 CASE CABLES

CONTINUING with even more cables, we need to attach all of the front panel case cables to our motherboard. This includes the power switch, USBs, HD audio, and fan cables. To get to grips with your motherboard, take a look through the official manufacturer's manual to find out exactly where to install each specific cable and to get fully familiar with your board. Luckily for us, the power switch cable was fixed together instead of being individual pins. These are always extremely awkward to install, especially if you've already installed the GPU, which is why we more than often leave that to the end.

10 SUPPLYING THE POWER

THE WHOLE SYSTEM would be a waste of time without this helpful component, our Corsair 1000W PSU. Based on design alone, it's one of our favorites to use, as the ports face towards the back opening of the case, making them very accessible. This way, we won't have an issue when installing the PSU cables—well, hopefully, anyway!

The PSU slides into the bottom of the case and screws in using four Philips screws. In our case, it didn't quite line up with the NZXT case perfectly, so we only managed to get the top two in. That's fine, but it feels like an annoying itch you just can't seem to reach!

11 DOT TO DOT

AS WE DID with the case cables, we now need to install the PSU cables from the power supply to our motherboard. These include 2x PCIe (for our GPU), 2x CPU cables, a SATA cable (for the NZXT pump and RGB fan controller), and last but not least, a 24-pin motherboard cable. Often, these are pretty awkward to fit, as they're very rigid, but thanks to plenty of channeling options in our case, this wasn't too much trouble.

We did have some issues with one of our PSU leads, though. This was a new one that was supposed to eliminate the need for a new RTX 40 series adapter. This 12VHPWR (12+4) pin cable is meant to go straight from the power supply to the GPU, but unfortunately one tiny cable in the lead was loose. We left this aside to avoid any issues, and chose to use 2x PCIe cables with the Zotac RTX 4070 splitter instead.

12 LAST BUT NOT LEAST

HARDWARE-WISE, we've nearly hit the end of the road. To celebrate, it's time to install our GPU. Before we do so, be sure to remove the 2nd and 3rd PCIe shroud on the back of the case to make way for the GPU's I/O. Then, just like the RAM, align the port into the slot on the motherboard, and press it down into place. You'll hear a click that is oh-so satisfying once you realize you haven't just destroyed your precious GPU! Then, tighten the GPU down further by screwing in the screws from the shrouds we took out earlier.

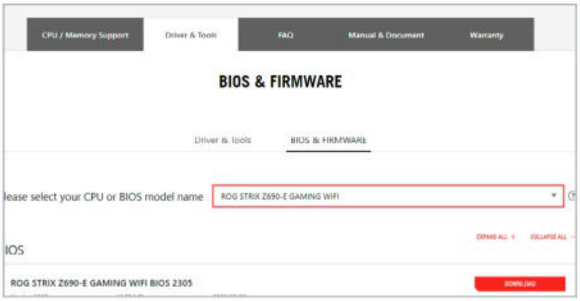
With that done, insert the PCIe RTX 40 series splitter into the GPU and attach the two PSU PCIe cables to it. Then, we can install the mount that came with the GPU to prevent any sagging. There you have it, one mighty PC ready for action—well, nearly!

ZOTAC
GEFORCE RTX

13 BIOS REFRESH

OUR Z690-E MOTHERBOARD needs updating. Head to the manufacturer's website and go to the support section. Click on Driver & Tools, BIOS & Firmware, then select ROG STRIX Z690-E GAMING WIFI. This will show you the latest official BIOS update. Once downloaded, open the file, double-click the BIOS renamer tool, and extract the file. Open the renamer tool, and it will open a terminal window.

The BIOS file will have been updated. You then need to drag this file to a clean USB drive that has been formatted to FAT32. Once the file has been added to the USB drive, shut down your system and insert it into the BIOS FLBK USB port on the back of the motherboard. Turn on your power switch on the PSU and press and hold the FLBK button for three seconds until the green light starts to flash. Let the system do its thing, and once it has stopped flashing, your motherboard will now be updated to the latest firmware.



BIOS & FIRMWARE

lease select your CPU or BIOS model name: ROG STRIX Z690-E GAMING WIFI

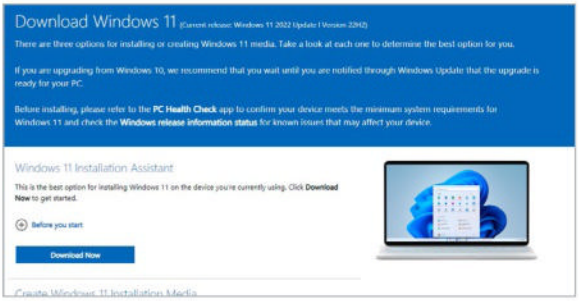
IOS

ROG STRIX Z690-E GAMING WIFI BIOS 2305

14 SENDING OUT AN S...OS

WITH AN UPDATED BIOS, we need to put a fresh copy of Windows onto our system. Using another system, format your USB to FAT32. Head to the official Microsoft Download Windows 11 page, and select 'Download Now' under 'Create Windows 11 Installation Media'. After downloading, open it up, and the installation wizard will run. Accept the on-screen instructions until you get to 'Choose which media to use'. Here, select 'USB Flash Drive'. This should then show you your clean FAT32 USB drive—select it, and continue to install Windows 11. Once downloaded, insert this USB into your new build, boot up your system, and it should load.

This is where we need to rearrange the boot priority order. Make sure that your drive is at the top, and hit save and exit to restart. This will boot into the Windows 11 Installation Wizard. Follow the instructions once more, and choose the options you want to personalize your system.



Download Windows 11 (Current release: Windows 11 2022 Update I Version 22H2)

There are three options for installing or creating Windows 11 media. Take a look at each one to determine the best option for you.

If you are upgrading from Windows 10, we recommend that you wait until you are notified through Windows Update that the upgrade is ready for your PC.

Before installing, please refer to the **PC Health Check** app to confirm your device meets the minimum system requirements for Windows 11 and check the **Windows release information status** for known issues that may affect your device.

Windows 11 Installation Assistant

This is the best option for installing Windows 11 on the device you're currently using. Click **Download Now** to get started.

Create Windows 11 Installation Media

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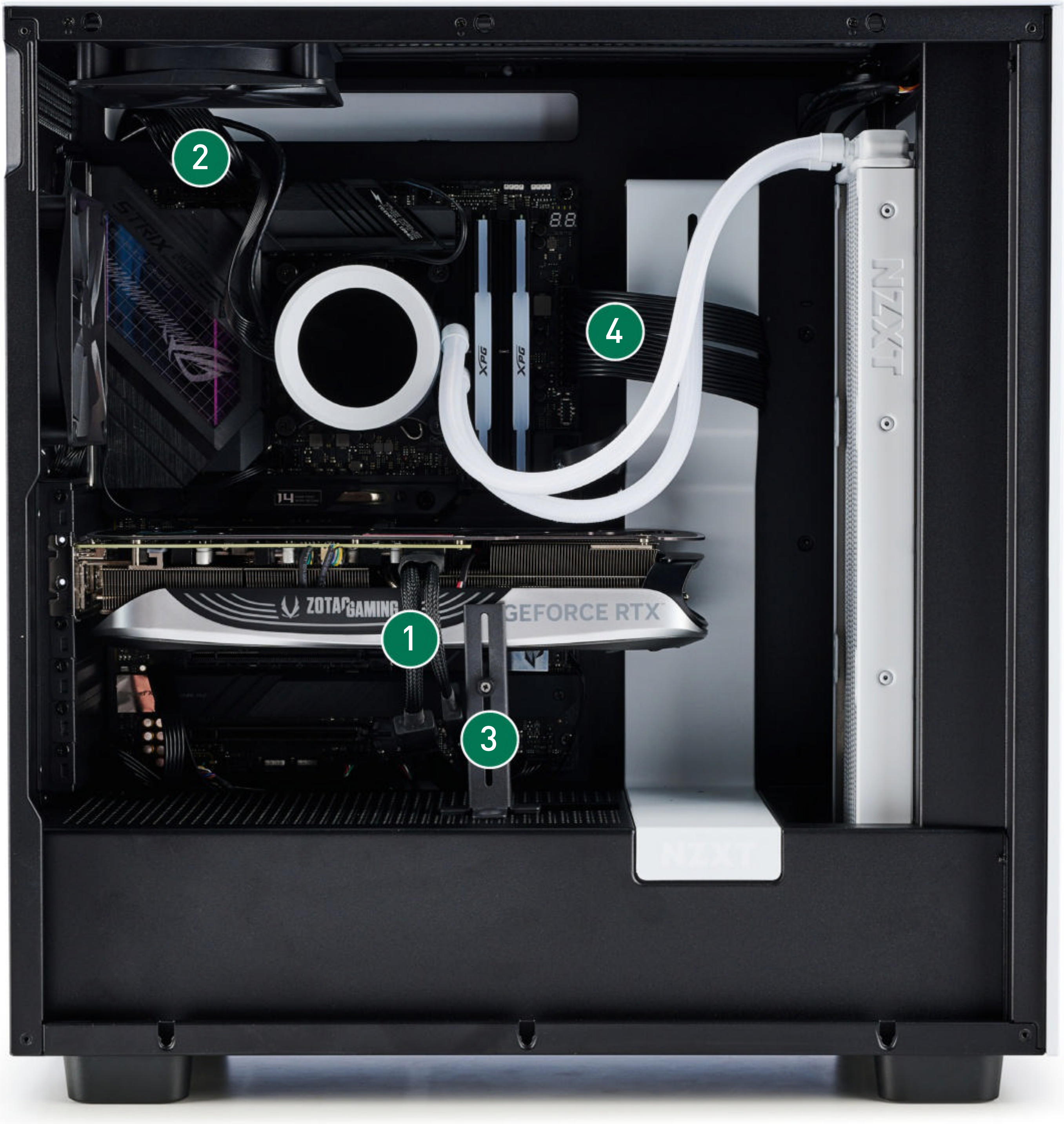
MOVING FORWARDS

1 It's a real shame that our Corsair 12+4 pin 12VHPWR power connector was faulty—it'd have looked cleaner here.

2 More cable woes are found in the top left corner. At least they are black and can be somewhat hidden.

3 Although effective, it's not the most attractive mount. One on the motherboard would stay hidden and still work well.

4 Unfortunately, due to the tight angle, we couldn't tuck our 24-pin motherboard cable behind the white shroud.



THE BEST VALUE PC OF 2023?

COMPARED TO SOME very recent builds, this one went extremely smoothly. From start to finish, even on the software end, it was reasonably plain sailing. Luck wasn't always on our side, but we managed to get this system built and set up quickly. We set out to achieve a machine that can be used both for work and pleasure, and we've most certainly done that here.

Other elements, such as futureproofing and budgeting, were also thrown into the mix. Although components such as the cooling and PSU are expensive, these should last a long time, and are equipped to handle more powerful processors and graphic cards in future. It's sometimes better to stretch your budget on components if you know you might want to swap things out later. We could have used a 750W PSU, but with the intent to upgrade to an RTX 4090 to further boost our gaming performance, that 750W PSU would dwindle at the sight of a card so power-intensive!

Aesthetically, we also feel that it ticks boxes for both a serious workstation and a gaming-focused rig, with the ability to flick on the Vegas lights quickly for a bit of gamer eye candy. The H7 case is playful, but can also be minimalistic, making it a great match for both teams. We are glad we went for the white variant of the NZXT Kraken Elite 360 RGB, as this pops against the black interior. Plus, there's an unlimited amount of creativity you can have when customizing the display, so we had fun adding memes and GIFs here.

Silliness aside, we only had a few niggles. The main one was when we first tried to boot our system up, we got a motherboard error code of 55, which related to a seating issue with our RAM. A quick reinstall fixed issues here. There was also the Corsair 12VHPWR (12+4) pin cable from our power supply that was faulty, meaning we had to go back and use the PCIe splitter from our GPU.

BENCHMARKS

Performance-wise, this machine rocked. Day-to-day, it powered through every task. We tried animation via Adobe After Effects, photo manipulation via Adobe Photoshop and GIMP, digital artwork via Adobe Illustrator, and even 3D modeling on Maxon. Alongside the Zotac RTX 4070, our Intel Core i5-13700K was fantastic. We benched this against the 8K Gaming Monster from our Holiday 2022 issue. which featured a more powerful Intel Core i9-13900K and GeForce RTX 4090.

We wanted to see what the differences would be between our machine and an all-out powerhouse like the 8K build. When looking at the Cinebench Results, we were happy to see only a 10 percent decrease in performance on the single-core score compared to the 13900K, and only a 15 percent decrease on the multi-core score. Considering the $150 difference between the two CPUs, we were pleasantly surprised with these results. The 3D mark score also wasn't far behind, as we scored 21,271 compared to the 24,528 that the 8K Gaming Monster machine got. For the SSD test, we beat that system, as our CrystalDisk scores were faster. The read speeds were nearly identical to the PNY XLR8 CS3140 SSD on the other machine, but the write speeds shone, winning by 25 percent.

Unfortunately, it's when we compare our gaming benchmarks that you can see the difference between the performance of our Zotac Gaming GeForce RTX 4070 TRINITY 12GB and the MSI GeForce RTX 4090 GAMING X TRIO 24GB. Our 4070 lagged behind by at least 46 percent compared to the bigger card. Of course, this was while being tested on ultra settings at 4K resolution and no manual overclocking. We were receiving FPS scores of between 19 and 53—decent considering how hard we were pushing it, but not what you'd want to game at.

We recommend gaming at either 1080p or QHD and turning down the dials to get a more seamless gaming experience overall. We wouldn't game at 4K on this system, but that shouldn't imply that it's not great for gaming. We were getting more than 100 fps at QHD resolution with medium to high settings—perfect for kicking back and immersing yourself in your favorite titles.

BENCHMARKS

	ZERO POINT	
Cinebench R23 Single-Core (Index)	2,247	2,016 (-10%)
Cinebench R23 Multi-Core (Index)	35,457	30,008 (-15%)
CrystalDisk QD32 Sequential Read (MB/s)	7,057	7,105 (1%)
CrystalDisk QD32 Sequential Write (MB/s)	5,303	6,620 (25%)
3DMark Fire Strike Ultra (Index)	24,528	21,271 (-13%)
Cyberpunk 2077 (fps)	78	42 (-46%)
Cyberpunk 2077 RTX (fps)	43	19 (-56%)
Metro Exodus (fps)	140	123 (-62%)
Metro Exodus RTX (fps)	105	36 (-66%)
Total War: Three Kingdoms (fps)	100	45 (-55%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the 8K Gaming Monster from our Holiday 2022 issue, featuring an Intel Core i9-13900K, MSI GeForce RTX 4090 GAMING X TRIO 24GB, Asus ROG Maximus Z790 Hero motherboard, 32GB (2x16) of Corsair Vengeance DDR5-5200, and 1TB PNY XLR8 CS3140 PCIe 4.0 M.2 SSD. All games tested at 4K 'Ultra' graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking.

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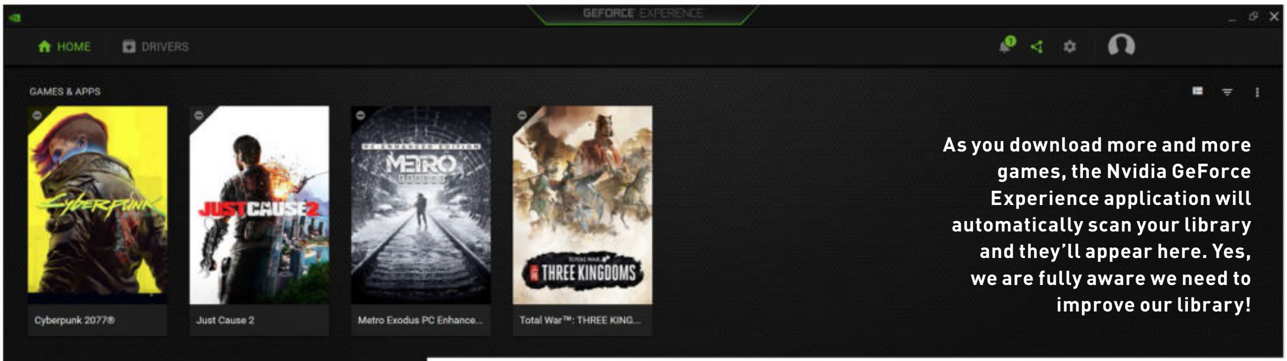
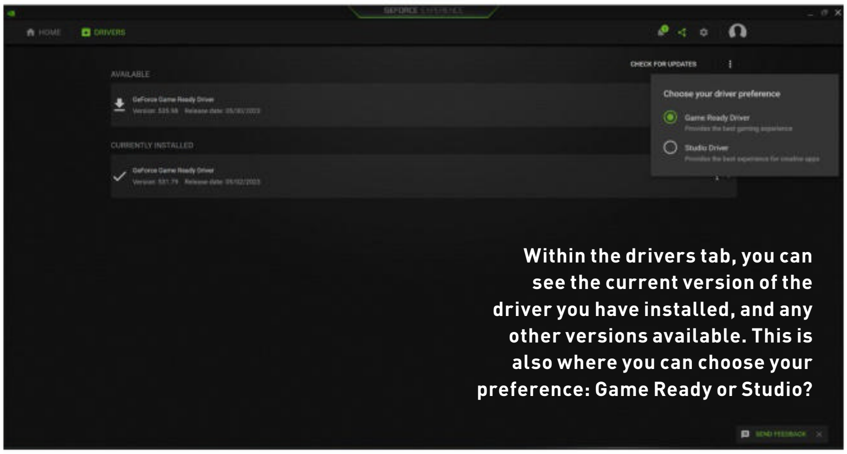
GAME READY DRIVER VS STUDIO DRIVER

FIND OUT WHICH NVIDIA GEFORCE DRIVER IS BEST FOR YOUR SYSTEM


GEFORCE EXPERIENCE
HOME
DRIVERS
GAMES & APPS
Cyberpunk 2077®
Just Cause 2
Metro Exodus PC Enhance...
Total War™: THREE KING...

As you download more and more games, the Nvidia GeForce Experience application will automatically scan your library and they'll appear here. Yes, we are fully aware we need to improve our library!


HOME
DRIVERS
CHECK FOR UPDATES
AVAILABLE
GeForce Game Ready Driver
CURRENTLY INSTALLED
GeForce Game Ready Driver
Choose your driver preference
● Game Ready Driver
Provides the best gaming experience
○ Studio Driver
Provides the best experience for creative apps
SEND FEEDBACK

Within the drivers tab, you can see the current version of the driver you have installed, and any other versions available. This is also where you can choose your preference: Game Ready or Studio?

IF YOU'RE USING an Nvidia GeForce graphics card like us, then you'll of course be accustomed to the Nvidia GeForce Experience application. This is vital to ensure that you can use your GPU properly and keep it running at its best. Without drivers, the card wouldn't be able to function correctly as the driver is what allows the computer to communicate with the graphics card in the first place.

As we're intending to use our system for both work and gaming, it leaves us in a bit of a predicament. Which driver shall we use, or can we use both? What even are these drivers, you may ask? Well, within the GeForce Experience application, there are options for a Game Read Driver (the default option) or a Studio Driver. So what's the difference between the two?

Before we quickly dive into the differences, it's important to know how to choose between the two and install one in the first place. First off, head over to the Nvidia GeForce Experience application. When on the home page, click the 'Drivers' button towards the top left. You can then click 'Check for updates' to find the latest drivers. Then, if you click the three dots on the right side of the screen you'll see options for your driver choice. Here, you can decide whether you want the Game Ready or Studio driver. Unfortunately, we can't install both at the same time, but switching between the two via this method won't take longer than a couple of minutes. Yes, it's frustrating, but it's worth the few minutes of your time.

THE DIFFERENCES

GAME READY DRIVER

If gaming is your priority then you're going to want to have this installed for the majority of the time! This is of course optimized to push your GPU to its graphical limits and provide you with drop-dead gorgeous gaming visuals. This driver will provide you with the latest and most up-to-date support for the latest games so that you can play your games as smoothly as possible. This is especially important if you are competitively playing the most current games where every little detail matters. The last thing you want here is for your games to crash or for any bugs to ruin your gameplay.

STUDIO DRIVER

If you're producing artwork, creating, designing, editing, or anything in between, then the Studio Driver is the more sensible choice for you. These have been tailored to more creation-oriented software and hardware. With fewer updates, more time is dedicated to each one ensuring more stability but less frequency than the Game Ready drivers. The main bodies of the drivers are relatively similar, but if you are creating large projects, especially if these aren't just hobbies but are for work, then you are going to want to opt for the Studio Driver as your main choice.

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dupeGuru
File
View
Help
Directories
Options
General
Display
Debug
Restore Defaults
OK
Cancel
−
+▾
oad Results▾
Scan
AORUS
PANTONE
RTX

Application Mode: ● Standard ○ Music ○ Picture

Scan Type: Filename

Select folders to scan and press "Scan".

Name	State
D:\Nick\NextCloud\Photos	Excluded
D:\Nick\NextCloud\Documents	Normal
F:\Family History	Normal

Filter Hardness: 98 (More Results – Fewer Results)

☑ Word weighting

☐ Match similar words

☑ Can mix file kind

☐ Use regular expressions when filtering

☐ Remove empty folders on delete or move

☑ Ignore files smaller than 10 KB

☐ Ignore files larger than 1000 MB

☐ Partially hash files bigger than 100 MB

☐ Ignore duplicates hardlinking to the same file

Copy and Move: Recreate relative path

Custom Command (arguments: %d for dupe, %r for ref):

Get your PC back to operating smoothly with our free Windows tips and apps.

STREAMLINE AND CLEAN UP WINDOWS

Strip the bloat from Windows and give it a spring-clean for a factory-fresh feel with *Nick Peers*

IS YOUR PC starting to creak under the weight of all your folders and installed apps? Before reaching for the nuclear 'clean reinstall' button, there's plenty you can do to spruce up your current installation.

The obvious solution is to perform a cleanup of key files, and naturally that's where we'll start with this feature. But we'll also show you how you can optimize Windows itself to reduce the strain and free up much-needed system resources to give your PC a welcome shot in the arm.

Throughout the course of this feature, we'll examine both Windows' own tools and the best third-party apps that money—well—can't buy. You see, we've gone the extra mile to track down only free system-cleaning and optimization tools. Not only will we show you how to tame your personal folders, we'll look at curbing some of Windows' worst excesses, too. You'll delete gigabytes of temporary files, learn how to thoroughly remove virtually all traces of a program from your hard drive, reclaim system resources at startup, and ensure that no unruly programs or processes can bring your PC grinding to a halt through their excessive demands. Ready for that spring clean? Don your oven gloves and turn the page...

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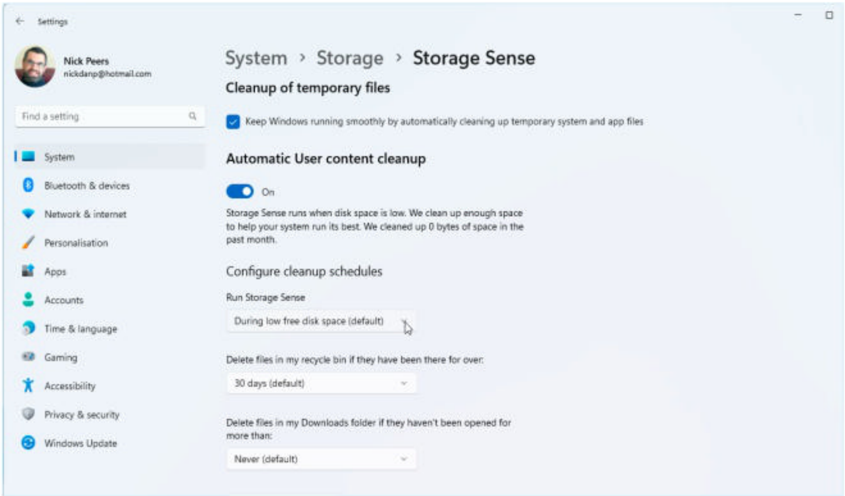
LET'S START our clean-up with a look at the tools offered by Windows. In the past, this would have involved the Disk Cleanup tool, which used to be accessible via the Tools tab of a drive's properties. That option is gone in Windows 11 (although the tool still exists—type 'disk cleanup' into the Search box to access it), to be replaced by the Storage Sense tool, which is baked directly into Settings under System > Storage.

Storage Sense is capable of cleaning everything Disk Cleanup can, and more besides. If its switch is set to On, it's pre-configured to automatically clear out temp and app files when your drive is almost full. Click Storage Sense to alter this behavior—you can change it to a daily, weekly, or monthly schedule if you prefer, plus configure how long items remain in the Recycle Bin before they're automatically removed (30 days is the default, but you can clear it out every 1, 14, or 60 days if you prefer, or disable the automatic purge completely).

By default, Storage Sense won't touch any files in your Downloads folder, but you can configure that separately to automatically purge files older than 1, 14, 30, or 60 days if you prefer. The tool is rounded off with a 'Run Storage Sense now' button if you'd like to run it manually based on your current settings.


Settings
Nick Peers
nickdanp@hotmail.com
Find a setting
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update

System > Storage > Storage Sense

Cleanup of temporary files

☑ Keep Windows running smoothly by automatically cleaning up temporary system and app files

Automatic User content cleanup

On

Storage Sense runs when disk space is low. We clean up enough space to help your system run its best. We cleaned up 0 bytes of space in the past month.

Configure cleanup schedules

Run Storage Sense: During low free disk space (default)

Delete files in my recycle bin if they have been there for over: 30 days (default)

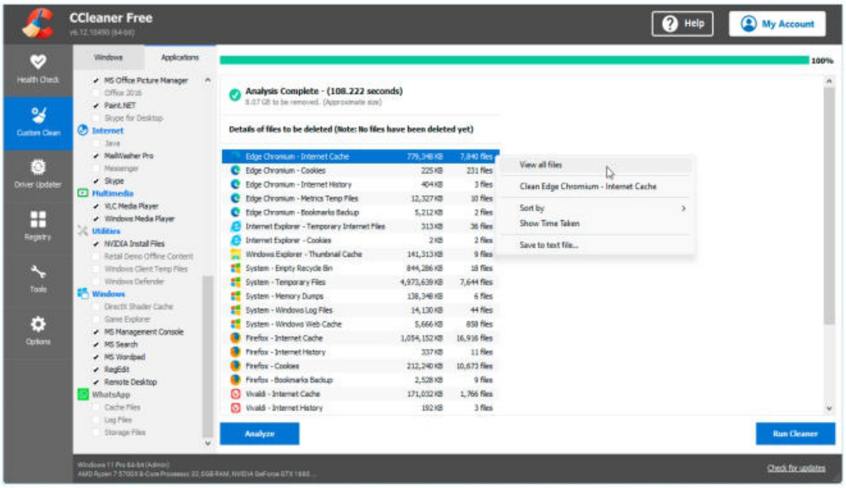
Delete files in my Downloads folder if they haven't been opened for more than: Never (default)

Windows 11 has its own tool for cleaning your system.

Alternatively, return to the previous level and click 'Cleanup recommendations' for a more detailed view of what else can potentially be cleaned from your system. You'll see another option to clear your Downloads folder, but click 'See advanced options' beneath to view a list of additional files Storage Sense will ditch. Peer closely, and you'll see that this is the same list as offered by Disk Cleanup, accompanied by a handy 'Remove files' button if you'd like to purge the checked items.

Return to 'Cleanup recommendations' to view three further expandable categories: 'Large or unused files', 'Files synced to the cloud' (exclusively related to your OneDrive account), and 'Unused apps'. They're largely self-explanatory, but there are better options for clearing all three, as we'll see shortly.

Rounding off our tour of Storage, expand 'Advanced storage settings' beneath 'Cleanup recommendations' for options relating to other drives. The only clean-up related category is 'Storage used on other drives'—simply click a drive to drill down through its contents, divided into categories ranging from Documents and Pictures to Mail and Temporary files). If you'd like to visualize your drive in a different way, check out the 'Visualize drive space' box.


CCleaner Free
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My Account
Health Check
Custom Clean
Driver Updater
Registry
Tools
Options
Windows
Applications
MS Office Picture Manager
Office 2016
Paint.NET
Skype for Desktop
Internet
Java
MailWasher Pro
Messenger
Skype
Multimedia
VLC Media Player
Windows Media Player
Utilities
NVIDIA Install Files
Retail Demo Offline Content
Windows Client Temp Files
Windows Defender
Windows
DirectX Shader Cache
Game Explorer
MS Management Console
MS Search
MS Wordpad
RegEdit
Remote Desktop
WhatsApp
Cache Files
Log Files
Storage Files
100%
View all files
Clean Edge Chromium - Internet Cache
Sort by
Show Time Taken
Save to text file...
Analyze
Run Cleaner
Check for updates

Analysis Complete - (108.222 seconds)

Details of files to be deleted (Note: No files have been deleted yet)

Edge Chromium - Internet Cache	779,348 KB	7,840 files
Edge Chromium - Cookies	225 KB	231 files
Edge Chromium - Internet History	404 KB	3 files
Edge Chromium - Metrics Temp Files	12,327 KB	10 files
Edge Chromium - Bookmarks Backup	5,212 KB	2 files
Internet Explorer - Temporary Internet Files	313 KB	36 files
Internet Explorer - Cookies	2 KB	2 files
Windows Explorer - Thumbnail Cache	141,313 KB	9 files
System - Empty Recycle Bin	844,286 KB	18 files
System - Temporary Files	4,973,639 KB	7,644 files
System - Memory Dumps	138,348 KB	6 files
System - Windows Log Files	14,130 KB	44 files
System - Windows Web Cache	5,666 KB	858 files
Firefox - Internet Cache	1,054,152 KB	16,916 files
Firefox - Internet History	337 KB	11 files
Firefox - Cookies	212,240 KB	10,673 files
Firefox - Bookmarks Backup	2,528 KB	9 files
Vivaldi - Internet Cache	171,032 KB	1,766 files
Vivaldi - Internet History	192 KB	3 files

CCleaner cleans the parts Storage Sense is afraid to reach.

PERFORM A DEEP CLEAN

Storage Sense is quite conservative in what it'll clean—if you want to go even deeper into your system, then you'll need to employ the services of a third-party tool. CCleaner (www.ccleaner.com) offers a Health Check scan that can scan for junk and trackers automatically, but we suggest choosing the Custom Clean option so you can see exactly what it finds and review all items before removing them.

Start by reviewing the list of items CCleaner plans to check. This is split into two tabs: Windows and Applications. In each, you'll see that all major browsers are featured, each with its own set of checkable options, some of which have been preselected. You can uncheck these manually, or if there's a browser you use regularly and don't want cleaned, simply right-click its title and choose 'Uncheck all'.

In addition to browser settings, you'll see various Windows settings and other applications are covered, too—again, make sure you uncheck any you regularly use before clicking the Analyze button. CCleaner will go through your selection and scan before providing a summary of how much space (and how many files) each section contains that will be cleaned if you click 'Run Cleaner'. To view results in more depth, double-click an entry. Right-click any files you wish to keep and choose 'Add to Exclude List' before returning to the previous screen.

In addition to cleaning all the entire selection, you can restrict yourself to individual apps or settings by right-clicking their entry and choosing 'Clean [app/setting name]'. Be very careful about what you delete—particularly when it comes to programs you use regularly.

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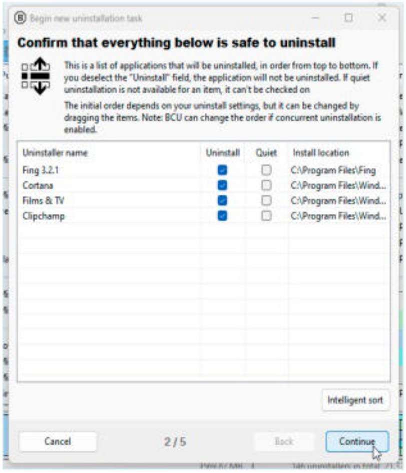


Confirm that everything below is safe to uninstall

This is a list of applications that will be uninstalled, in order from top to bottom. If you deselect the "Uninstall" field, the application will not be uninstalled. If quiet uninstallation is not available for an item, it can't be checked on

The initial order depends on your uninstall settings, but it can be changed by dragging the items. Note: BCU can change the order if concurrent uninstallation is enabled.

Uninstaller name	Uninstall	Quiet	Install location
Fing 3.2.1	☑	☐	C:\Program Files\Fing
Cortana	☑	☐	C:\Program Files\Wind...
Films & TV	☑	☐	C:\Program Files\Wind...
Clipchamp	☑	☐	C:\Program Files\Wind...

Install multiple apps in one go with Bulk Crap Uninstaller.

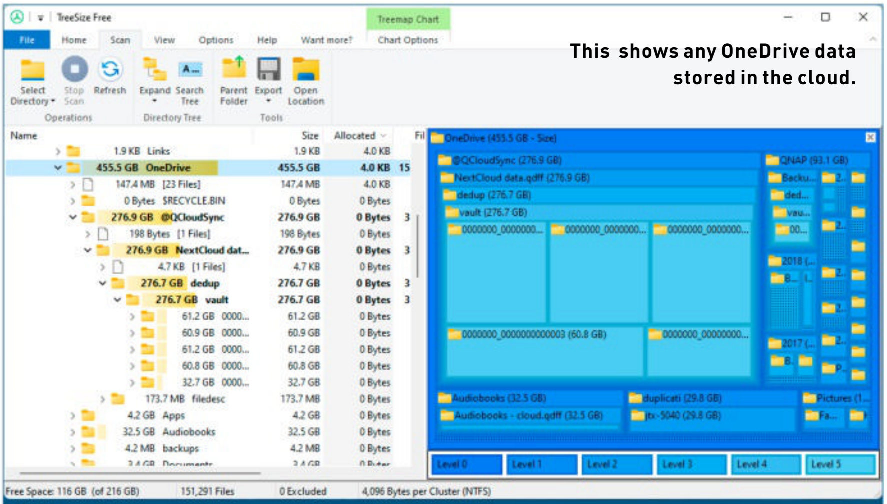
CCleaner also includes a Registry Cleaner, but we strongly advise against using it—Registry cleaners are notoriously hit and miss when it comes to clearing out supposedly redundant entries, and you could end up causing major problems to your system. If you must give it a whirl, take a System Restore point before you begin (type 'system restore' into the Search box) and back up the Registry when prompted before deleting anything, so you can restore things back to the way they were simply by double-clicking the .reg backup file and choosing to merge its contents back into the Registry.

CLEAN OUT UNWANTED PROGRAMS

Next, let's streamline the programs installed on your system. Chances are you've got a few redundant apps on your hard drive—and who knows what system resources they may be consuming in the background, even though they're no longer used?

The obvious port of call is to navigate to 'Settings > Apps > Installed apps.' This provides a summary of what programs are on your PC, plus options for removing unwanted ones. The problem is that Windows relies on the program's own uninstaller to do the job, and these are notorious for leaving behind all kinds of clutter, including files and Registry entries.

There are plenty of third-party uninstallers out there, all of which promise to go further by rooting out leftovers to ensure most—if not all—of a program's traces are removed from your system. But many of these are problematic—either bundleware (attempting to foist unwanted software on to you every time you install or update the program) or full of pop-up ads.



Name	Size	Allocated	Fil
1.9 KB Links	1.9 KB	4.0 KB	
455.5 GB OneDrive	455.5 GB	4.0 KB	15
147.4 MB [23 Files]	147.4 MB	4.0 KB	
0 Bytes $RECYCLE.BIN	0 Bytes	0 Bytes	
276.9 GB @QCloudSync	276.9 GB	0 Bytes	3
198 Bytes [1 Files]	198 Bytes	0 Bytes	
276.9 GB NextCloud dat...	276.9 GB	0 Bytes	3
4.7 KB [1 Files]	4.7 KB	0 Bytes	
276.7 GB dedup	276.7 GB	0 Bytes	3
276.7 GB vault	276.7 GB	0 Bytes	3
61.2 GB 0000...	61.2 GB	0 Bytes	
60.9 GB 0000...	60.9 GB	0 Bytes	
61.2 GB 0000...	61.2 GB	0 Bytes	
60.8 GB 0000...	60.8 GB	0 Bytes	
32.7 GB 0000...	32.7 GB	0 Bytes	
173.7 MB filedesc	173.7 MB	0 Bytes	
4.2 GB Apps	4.2 GB	0 Bytes	
32.5 GB Audiobooks	32.5 GB	0 Bytes	
4.2 MB backups	4.2 MB	0 Bytes	

Free Space: 116 GB (of 216 GB) | 151,291 Files | 0 Excluded | 4,096 Bytes per Cluster (NTFS)

This shows any OneDrive data stored in the cloud.

VISUALIZE DRIVE SPACE

If you've ever wondered where all your drive space has gone, it can help to visualize your drive in such a way that large files are revealed, however deep they're nested inside folders. There are several tools out there that can 'map' your drive in this way, but our favorite is TreeSize Free (www.jam-software.com/treesize_free).

Download the free version—you have a choice of installer or portable build—and launch it. For full access to your system drive, click 'Start TreeSize Free as Administrator' when the main screen appears. Next, click the Select Directory button to select a drive or folder to scan and wait while a folder list is generated, with folders displayed in order of size. One caveat: your user folder may be listed as being much larger than it actually is, as if you have OneDrive set up, TreeSize Free will include the size of everything in your OneDrive storage (even if the files aren't physically on your machine).

You can expand folders to drill down through their contents, following the largest subfolders until you identify large files, or switch to the View tab and click 'Show Treemap Chart' to get a visual overview of the selected drive or folder.

If you find any files or folders you want to delete to free up space, simply right-click them to bring up the File Explorer context menu, complete with 'Delete' option. Don't forget to hold the Shift key if you want to bypass the Recycle bin to delete the file immediately and free up the space.

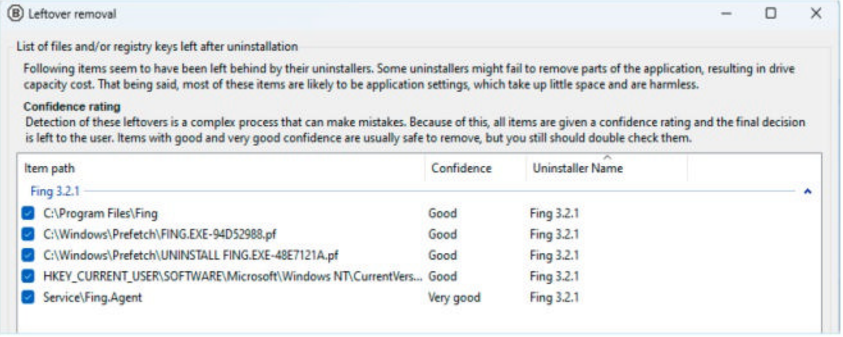
Thankfully, one tool—the open-source Bulk Crap Uninstaller—isn't afflicted by these problems. Its user interface isn't as slick as those other tools, but once you know how it works, it's straightforward enough. For a full rundown of its advanced features, head over to www.bcuninstaller.com, where you can download it as an installer or run it standalone as a portable app (see the box for how portable apps can help keep your system clean).

REMOVE ALL TRACES

Removing a single application using BCU is straightforward: launch the app and wait for it to scan your system for detected programs (including apps installed through the Microsoft Store). Uncheck 'Show unregistered applications' under Filtering to hide all entries colored red from view. Unregistered applications are technically those that haven't been registered in the Windows Registry, but the scan may also include any program installers you've stored for future use, so these are usually best ignored.

Above the list, you'll see a series of buttons, including two marked 'Uninstall' and 'Uninstall quietly' respectively. 'Uninstall quietly' attempts to remove apps without requiring any additional input from you—it's particularly useful when combined with BCU's ability to removal multiple apps in one go (simply Ctrl-click each unwanted program before clicking 'Uninstall quietly'). For now, though, let's focus on removing one app and seeing how the program works.

© BULK CRAP UNINSTALLER, TREESIZE FREE



Leftover removal

List of files and/or registry keys left after uninstallation

Following items seem to have been left behind by their uninstallers. Some uninstallers might fail to remove parts of the application, resulting in drive capacity cost. That being said, most of these items are likely to be application settings, which take up little space and are harmless.

Confidence rating
Detection of these leftovers is a complex process that can make mistakes. Because of this, all items are given a confidence rating and the final decision is left to the user. Items with good and very good confidence are usually safe to remove, but you still should double check them.

Item path	Confidence	Uninstaller Name
Fing 3.2.1		
☑ C:\Program Files\Fing	Good	Fing 3.2.1
☑ C:\Windows\Prefetch\FING.EXE-94D52988.pf	Good	Fing 3.2.1
☑ C:\Windows\Prefetch\UNINSTALL FING.EXE-48E7121A.pf	Good	Fing 3.2.1
☑ HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows NT\CurrentVers...	Good	Fing 3.2.1
☑ Service\Fing.Agent	Very good	Fing 3.2.1

Bulk Crap Uninstaller can also mop up after messy uninstallers.

Locate your app in the list, then right-click it and choose Uninstall. A wizard will open listing the program with Uninstall checked, but Quiet unchecked. Click Continue. BCU will check to see if any apps require closing before proceeding to the next stage. Here, you'll see a list of uninstallation settings, from preventing Windows from restarting during the removal process to configuring how quiet uninstallation will run to bypass potential blockages. In most cases, the default settings are fine, so click Continue again. Read the summary, then click 'BEGIN UNINSTALLATION'.

A pop-up will appear alongside the program's own uninstaller prompts. Once you've selected these and the program has been removed, click Continue followed by Yes when asked if you want to look for program leftovers (check 'Remember Choice' to have BCU do this automatically in the future). A scan will be performed, and then BCU will display a list of items (files, folders and/or Registry entries) that it's found along with a confidence rating as to whether it's a likely leftover or not. Roll your mouse over any partially obscured entries like Registry entries to view the full string as a pop-up.

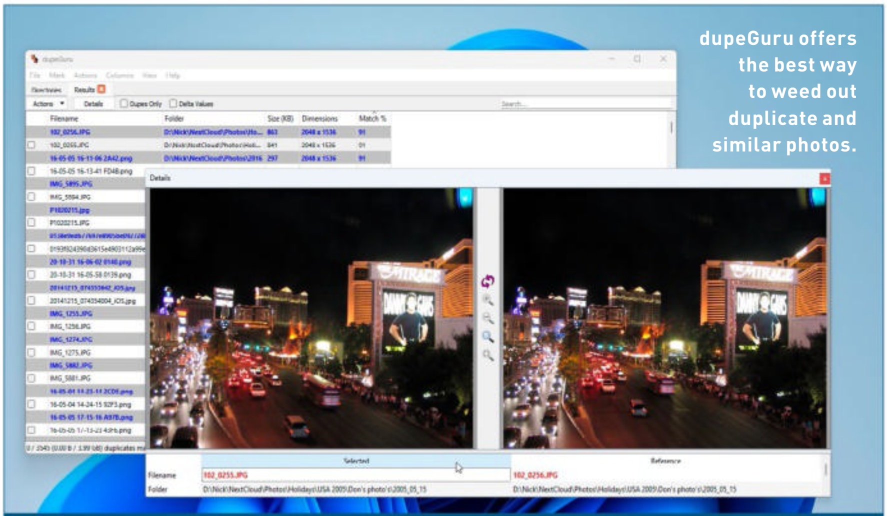
Once reviewed, uncheck any items you're not sure of and click Delete Selected to complete the program removal, choosing Create when prompted to create a Registry backup, just in case. Once done, you'll be returned to the main BCU interface, ready to move on to the next app.

FREE UP MORE DRIVE SPACE

So far we've focused on Windows and your apps—we'll return to paring that back even further shortly—but for now, let's take a sideways step and look at clearing more redundant files from your hard drives. We'll focus on your personal documents, photos, and other files—not just exact duplicates, but visually similar photos too.

CCleaner offers a Duplicate Finder under its Tools section—it's worth trying if you're only interested in weeding out exact duplicates of files. The default settings match by name, size, and modified date, with some sensible ignore options (like system and hidden files) set by default, but make sure you don't leave yourself with a single copy of any precious files—if you have files backed up somewhere, exclude those drive locations from your searches via the Exclude tab before clicking Search.

If you want to go further, we recommend switching to a different tool. One of the best freebies we've come across is dupeGuru (https://dupeguru.voltaicideas.net/), which is effectively three duplicate-finding tools in one, with specialist options for tracking down pictures (including visually similar, but not identical photos) and music. Once installed, launch the program, and you'll see a choice of three application modes: Standard (the default), Music, and Picture. You'll also see a 'Scan Type' dropdown, which varies according



dupeGuru offers the best way to weed out duplicate and similar photos.

TRIM YOUR PHOTO COLLECTION

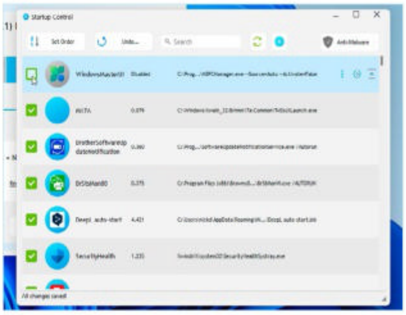
It's been over 20 years since we shifted from film to digital photography, but the era of trying to make sure every shot counted is long forgotten. Now, we'll routinely snap multiple shots of the same scene with the aim of going through them later to pick out the best one. But are you diligently doing this?

If not, your hard drive is likely to be filling up with hundreds of redundant shots. This is where dupeGuru's hardness filter comes in—by experimenting with reducing it by 5 or even 10 percent, you may be able to take the hassle out of identifying and removing all those imperfect photos to leave you with just the best-looking. Remember, though, that the lower the score, the more potential matches will be found, and the slower the scan.

Of course, you'll need to be able to inspect each photo to see which is best, which is where dupeGuru rides to the rescue again. When searching for photo duplicates, clicking the Details button will open a separate preview window, which can be left floating or dragged and docked to the main dupeGuru window if you prefer. Click the two matches one after the other to display them side-by-side.

The Match % field comes into its own here—photos with 100% matches are obvious duplicates, while most 99% matches can be safely regarded as duplicates too. As the figure drops, the differences between the two increase, so even if you're only using dopeGuru to root out duplicates, make sure you perform a visual inspection of any files with a Match of 98% or less.

© DUPEGURU, BULK CRAP UNINSTALLER



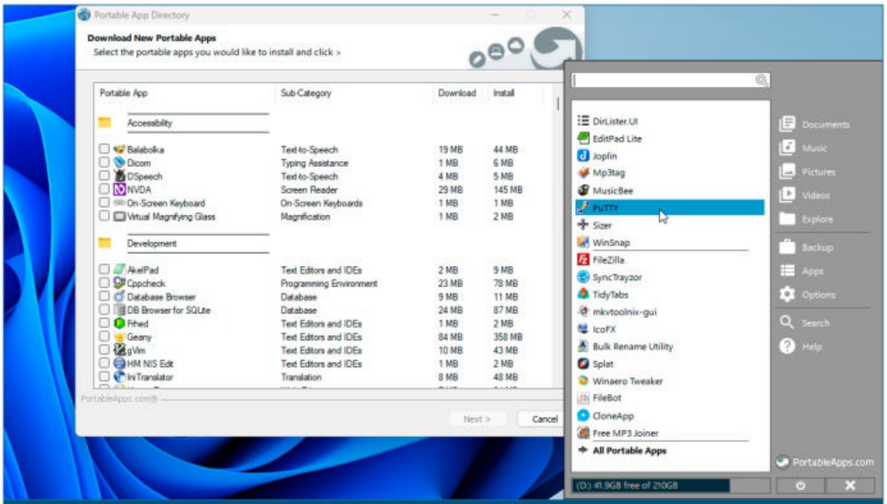
BootRacer measures your startup time to help identify start-up hogs.

to the application mode you choose. For example, Standard offers three types of scan: Filename, Contents (default), and Folders, while Picture restricts you to Contents and EXIF Timestamp.

Depending on your choice of application mode and scan, dupeGuru will deploy a different method for scanning and comparing content. Filename-based searches use 'Worded scans', which extract strings of text from each filename, and then compares them to determine whether there's a potential match based on 'filter hardness', which is a customizable percentage figure that determines how closely the filenames must match (click the 'More Options' box next to the scan type to configure this). Worded scans are also employed when searching for Music, which can find matches based on tags like artist or track name.

Content-based scans are much simpler (and more accurate)—the content of the file rather than its filename determines if it's a match or not. This doesn't require a byte-for-byte comparison, but is achieved by comparing file sizes and MD5 hashes. Because the match needs to be identical, the filter hardness isn't required and so is ignored. When searching for visually similar and identical pictures, dupeGuru employs a different method called 'Picture blocks'. Because this is the slowest and most thorough scan of all, dupeGuru caches its results in a database to speed up future searches.

Finally, the Folder-based scan finds identical folders by comparing their content. It's a similar type of scan to 'Worded scans' in that it's the various attributes of each file within a folder that is compared, and like filename searches, you're able to customize how close the match needs to be using the hardness filter. To set this filter, click the 'More Options' box next to the 'Scan Type' dropdown. You'll find that various settings can be customized here, but in most cases, you'll access this simply to tweak the hardness filter setting.



Download New Portable Apps
Select the portable apps you would like to install and click >

Portable App	Sub Category	Download	Install
Accessibility			
☐ Balabolka	Text-to-Speech	19 MB	44 MB
☐ Dicom	Typing Assistance	1 MB	6 MB
☐ DSpeech	Text-to-Speech	4 MB	5 MB
☐ NVDA	Screen Reader	29 MB	145 MB
☐ On-Screen Keyboard	On-Screen Keyboards	1 MB	1 MB
☐ Virtual Magnifying Glass	Magnification	1 MB	2 MB
Development			
☐ AkelPad	Text Editors and IDEs	2 MB	9 MB
☐ Cppcheck	Programming Environment	23 MB	78 MB
☐ Database Browser	Database	9 MB	11 MB
☐ DB Browser for SQLite	Database	24 MB	87 MB
☐ Fihed	Text Editors and IDEs	1 MB	2 MB
☐ Geany	Text Editors and IDEs	84 MB	358 MB
☐ gVim	Text Editors and IDEs	10 MB	43 MB
☐ HM NIS Edit	Text Editors and IDEs	1 MB	2 MB
☐ IniTranslator	Translation	8 MB	48 MB

BUILD A PORTABLE TOOLKIT

Forgive us if we sound like a broken record, but we're big fans of portable apps at *Maximum PC*. Not only can portable apps be transported from PC to PC, they're a great way to stop your system getting cluttered—and they survive reinstalls intact.

While portable apps are designed to be run on portable medium such as a flash drive, you can easily store them on any hard drive—including a dedicated folder on your system drive. You could even store it inside your cloud storage, so it's backed up as well as portable.

You can manually create shortcuts to portable apps for storing on the desktop or taskbar, but we recommend downloading and installing the PortableApps Platform (https://portableapps.com/), which provides you with a launcher, as well as access to over 100 apps that are available in portable format.

You can manually add apps to the launcher, too—copy the app folder into the main PortableApps folder, open the launcher, and click 'Apps > Refresh App Icons'—the app should appear under Other (if it doesn't, see https://portableapps.com/node/20906). To move it to a different section, right-click the app shortcut, and then open the Category submenu.

You can also mark frequently used apps as favorites, so they appear above other entries. Because they're portable and self-contained, the only limit to how many you set up is available drive space, while the only drag on your system will occur when they're physically up and running.

SCAN, COMPARE AND DELETE

Once you've got your scan mode and type set up, click + to add the first folder or drive whose content you wish to scan for duplicates. If you're looking to compare two distinct folders or drives, click + again to add more drives, folders, or subfolders as required. Note the State column—if you've selected two folders to compare with each other, take the time to set one of folders as 'reference' using the State dropdown menu. This tells dupeGuru that's the folder containing the files you wish to keep in the event of any duplicates being found. More on reference versus normal below.

Once you've selected where you'd like dupeGuru to search, click Scan, and a pop-up progress dialog will keep you informed as to how the scan is going. This can take some time to complete—particularly if you're scanning non-SSD drives or running on a low-powered PC—so be prepared to leave dupeGuru to its own devices for as long as it needs (the progress bar is pretty accurate, so you should be able to gauge how long that will be pretty quickly). Picture searches are particularly slow, but on the upside, dupeGuru stores its results in a database so future repeat searches are much quicker (you can save even more time by saving the results of specific scans via the File menu, then load them back in later).

When the scan finally completes, the results will be displayed as matching pairs with a summary of the results (including

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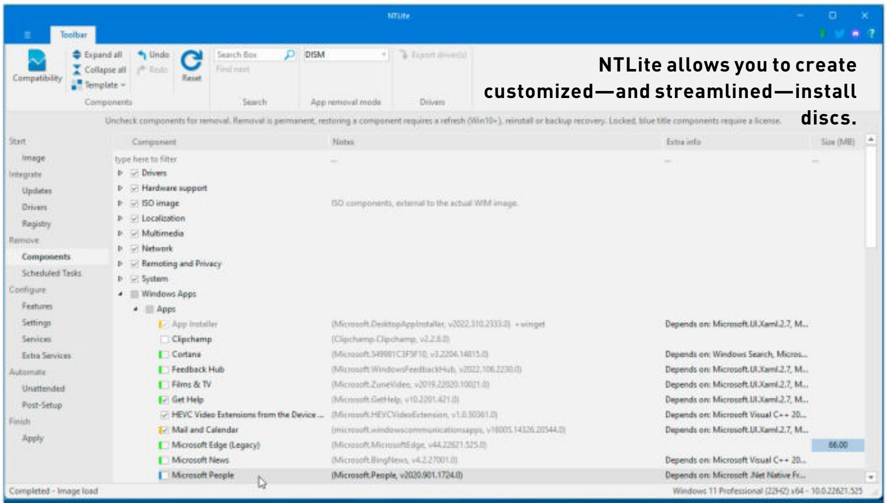


NTLite allows you to create customized—and streamlined—install discs.

BUILD A STREAMLINED INSTALL DISC

If you're considering reinstalling Windows, then why not save yourself a lot of post-reinstall work optimizing your system by building a customized install disc that ditches all the unwanted elements? The tool for the job is NTLite (www.ntlite.com). After installation, choose the free, non-commercial license. Next, download the latest ISO installer file for your version of Windows (www.microsoft.com/software-download/windows11). After launching NTLite, click the Add button on the Image tab of the menu and choose 'Image (ISO, WIM, ESD, SWM)' to open your downloaded ISO file in read-only mode.

When it appears in the list, expand the Operating systems dropdown menu to reveal the different editions available. Double-click your edition (Typically Windows 11 Home or Windows 11 Pro), and click OK. Wait for your selected edition to be written to the cache—when complete, you'll see its gray button turn green.

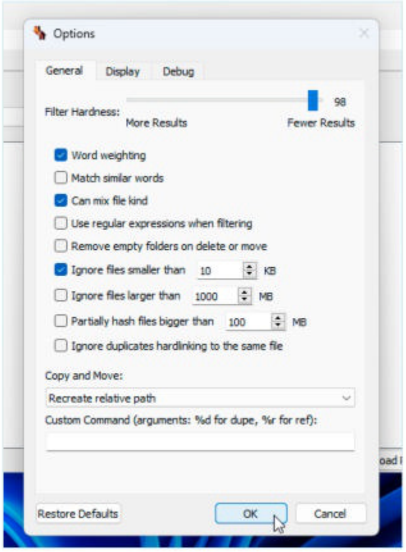
From here, it's a case of working through the categories on the left to customize your install disc—when streamlining your Windows install, focus on the Remove section (note the recommendation to test your finished ISO image). You can strip drivers and core components, as well as Windows apps from your installation disc.

Once you've made your changes—you can integrate third-party drivers and the latest Windows updates into the disc, as well as other components—go down to Apply and check 'Create ISO', before clicking the Process button. This will generate a fresh ISO image you should test in a virtual environment like VirtualBox (www.virtualbox.org) to check Windows installs and runs correctly before turning it into physical media and using it to install your fresh, tailored version of Windows.

how much drive space you can potentially save) beneath them. dupeGuru will make one file 'reference' copy (this will be left untouched) and any other matches will be deemed 'marked'. You'll see that marked entries have a box next to them, which needs to be checked if you want to mark the file for deletion, moving or copying.

To help confirm matches, you'll see the results display each file's name, folder location, size, and match % to help you confirm the match. There's also a Delta Values box—check this, and the marked file will change to display the differences in filename, size, and dimensions between it and the reference file (any negative figure indicates the marked file is smaller than the reference). Resolving photo matches requires a little more work—see the box for details.

Once you've identified a file to remove, place a check mark against it and press Ctrl + D. dupeGuru will pop up a dialog giving you two further options: one creates a link to replace the deleted file with a symlink or hard link, the other allows you to bypass the Recycle bin. Click Proceed when you've made your choices.



Options

General | Display | Debug

Filter Hardness: 98

☑ Word weighting
☐ Match similar words
☑ Can mix file kind
☐ Use regular expressions when filtering
☐ Remove empty folders on delete or move
☑ Ignore files smaller than 10 KB
☐ Ignore files larger than 1000 MB
☐ Partially hash files bigger than 100 MB
☐ Ignore duplicates hardlinking to the same file

Copy and Move: Recreate relative path

Custom Command (arguments: %d for dupe, %r for ref):

Use the hardness filter to determine how closely dupeGuru matches files.

Unless you've specified a folder as a reference file, you don't control which file or folder is considered the original, and which will be removed. Thankfully, you can override dupeGuru's choice by selecting the file you wish to keep, then press Ctrl + Space to make it the reference file instead.

It's likely you'll be presented with dozens or even hundreds of results. You can check multiple items in one go, or select the lot (Ctrl + A), but a better approach is to work through the list in batches. Once files are deleted, the references disappear from the search results. At the end of your session, press Ctrl + S to save the current results as a file to your hard drive. When you next launch dupeGuru, use the 'Load Results' button next to the Scan button to restore them and carry on where you left off.

MANAGE SYSTEM RESOURCES EFFICIENTLY

Many of Windows' performance problems can be traced to errant programs, processes, or Services grabbing more than their fair share's worth of system resources. Task Manager's Efficiency mode offers one way to rein in individual processes, but another way is to take an audit of what starts with your PC and strip out unnecessary programs. Aside from your security software, most start-up items are there purely for your convenience or—worse still—the program's own benefit.

There are several tools we recommend for the job of clawing back system resources. If you want to benchmark your current setup before streamlining

© NTLITE, DUPEGURU

startup, dig out your copy of the January 2023 issue, and turn to page 64 to find out about Boot Racer (https://greatis.com/bootracer/). It can also remove some unwanted programs from startup, but if you want to dig deeper then open CCleaner and navigate to Tools > Startup, where you'll find four tabs containing items you can disable: Windows covers the same list as offered by Boot Racer, while Scheduled Tasks reveals yet more apps performing behind-the-scenes tasks. Context Menu allows you to streamline the menu that appears when you right-click items in File Explorer, while Windows Services reveals third-party services in the background—double-click one to disable it.

TRIM MORE FAT

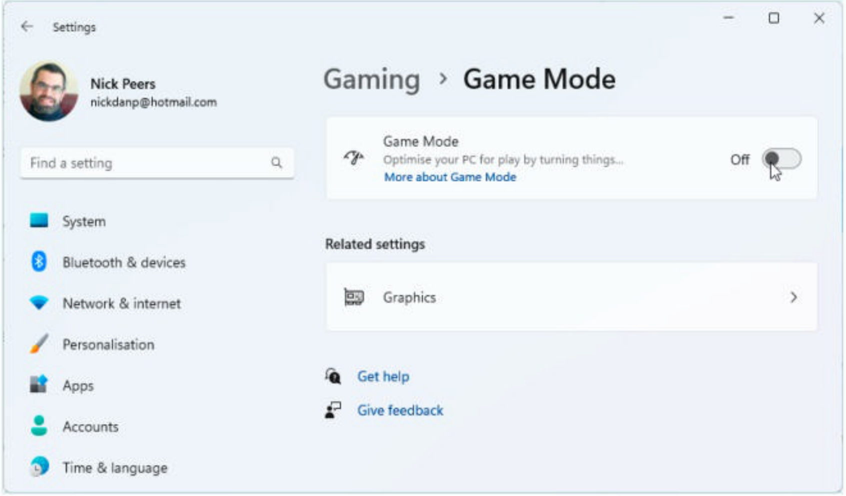
Windows doesn't let you choose what components you get when it's installed on your PC. Some can be removed manually using Bulk Crap Uninstaller, but others require deep dives, such as the 'Turn Windows features on or off' Control Panel. One way to get rid of all this is to build your own Windows installation media prior to reinstalling Windows with all unwanted apps and addons removed—the final box reveals how to do so via NTLite.

If that's a bit drastic, you can cut a little more fat with the help of Chris Titus Tech's Windows Utility (https://christitus.com/windows-tool/). While the tool may have an option to undo any tweak, this is low-level stuff we're getting involved with, so take a fail-safe backup now using your drive-imaging tool of choice, such as Hasleo Backup Suite Free (www.easyuefi.com). Once that's in place you're ready to continue. First, right-click the Start button and choose Terminal (Admin). Now, enter the following command:

```
irm christitus.com/win | iex
```

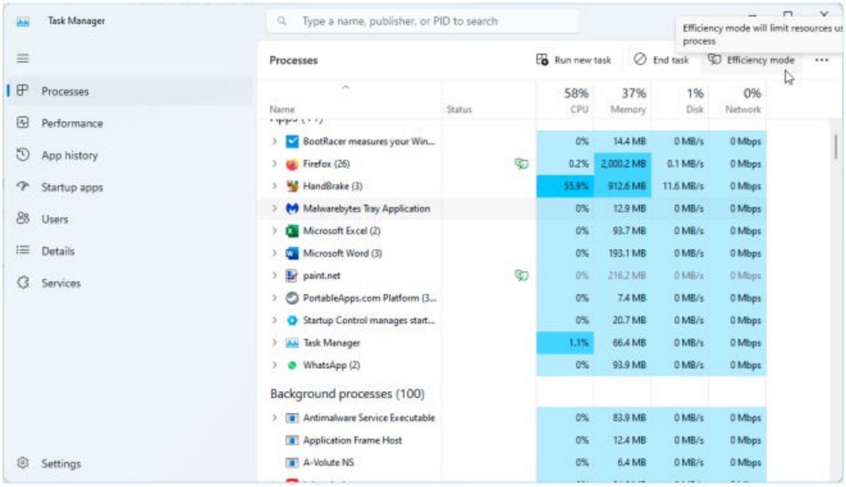
When prompted, install Chocolatey and wait for the Terminal to finish spitting out commands before the program window opens. It offers four tabs—the Install tab provides an easy way to install (and remove) various utilities, so it can be safely ignored. Instead, switch to the Tweaks tabs, where you'll find a wide selection split into Essential and Misc. categories. Most are self-explanatory, but you can get a jump-start by clicking Desktop or Laptop for a pre-selected list of recommended settings that should be safe (the program will automatically take a System Restore point if you run into problems, which in most cases should undo your changes with no after-effects).

The Chris Titus utility is naturally conservative with its selection, but for day-to-day use you should enjoy a small but noticeable boost—particularly on low-powered machines. If you want to push things further, then keep reading.



Game Mode
Optimise your PC for play by turning things...
Off

Ironically, disabling Gaming Mode can give your system a little boost.



Efficiency mode will limit resources us
process

Processes

Name	Status	58% CPU	37% Memory	1% Disk	0% Network
BootRacer measures your Win...		0%	14.4 MB	0 MB/s	0 Mbps
Firefox (26)	🍃	0.2%	2,000.2 MB	0.1 MB/s	0 Mbps
HandBrake (3)		55.9%	912.6 MB	11.6 MB/s	0 Mbps
Malwarebytes Tray Application		0%	12.9 MB	0 MB/s	0 Mbps
Microsoft Excel (2)		0%	93.7 MB	0 MB/s	0 Mbps
Microsoft Word (3)		0%	193.1 MB	0 MB/s	0 Mbps
paint.net	🍃	0%	216.2 MB	0 MB/s	0 Mbps
PortableApps.com Platform (3...		0%	7.4 MB	0 MB/s	0 Mbps
Startup Control manages start...		0%	20.7 MB	0 MB/s	0 Mbps
Task Manager		1.1%	66.4 MB	0 MB/s	0 Mbps
WhatsApp (2)		0%	93.9 MB	0 MB/s	0 Mbps
Background processes (100)					
Antimalware Service Executable		0%	83.9 MB	0 MB/s	0 Mbps
Application Frame Host		0%	12.4 MB	0 MB/s	0 Mbps
A-Volute NS		0%	6.4 MB	0 MB/s	0 Mbps

Windows 11's new Efficiency mode reins in runaway apps.

© MICROSOFT

QUICK AND DIRTY RESOURCE GRAB

In the past, third-party optimization tools made much of being able to pause services and applications when you wanted to focus on resource-intensive tasks, most notably playing games. Windows 11 offers this as built-in functionality with its Game Mode. Ironically, this works by reserving system resources in the event of you launching a game, and is switched on by default. Therefore, if heavy gaming isn't a priority, you might be able to give your system a boost by switching it off: navigate to 'Settings > Gaming > Game Mode' to do so. You can always enable it on an ad-hoc basis.

Windows 11 also introduces a new feature to Task Manager: Efficiency mode. Some apps—your browser may be one—may already be subject to it, but you can target other processes that appear to be consuming vast amounts of CPU or RAM, too. Select the errant process and see if the 'Efficiency mode' button becomes active. Click it to read a warning, then click OK to enable. You'll see the green leaf appear under its Status. If you run into problems, simply click the 'Efficiency mode' button again to disable it.

One final tool worth considering is Process Lasso (https://bitsum.com). This focuses its attention on the day-to-day running of your computer, and the free version is all you need to ensure any processes that threaten to grind your system to a halt are reined in to ensure smoother running of your system. Think of it as Efficiency mode on steroids, with no further action required on your part. If you like the concept, but want full control over the process, unlock the Pro version ($40 lifetime, $25 one-year). ⏻

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HOW TO BE INVISIBLE ONLINE

Robert Irvine recommends the best new ways to stay anonymous online by switching to more effective anti-tracking tools

WHAT YOU CAN DO

- Combine the privacy benefits of Tor with a VPN.
- Clear your cookies and browsing data in one click.
- Stay anonymous with a VPN without paying for a subscription.
- Stop your ISP seeing which websites you visit.
- Search the web without your data being collected.
- Fake your data so sites can't identify and track you.
- Disable hidden settings that secretly leak your information.

THREATS TO OUR ONLINE PRIVACY are constantly evolving. Advertising companies are finding new ways to track us, websites are developing new methods of collecting our data, and even the operating systems we use every day like Windows 11 are now trying to sell us something as we just go about our work and tasks.

This makes it more difficult than ever to preserve your anonymity as you browse the web, and essential to ensure you're using reliable methods to combat the latest threats. Thankfully, there's no shortage of privacy tools, and names such as Brave, DuckDuckGo, and NordVPN will be familiar to most readers. But in the past year, lots of new options have emerged that potentially offer better protection than the software and services you currently use, while existing tools have added powerful new privacy features.

To keep you updated on these developments, we have rounded up the best new private browsers, VPNs, search engines, and more to keep you invisible in the face of rising demand for your personal information. We've focused on boosting your privacy on your PC, because staying anonymous on your phone is a feature in itself, but we do cover new options in some service's mobile apps.

First, however, we explode the most common privacy myths to explain why your browser's anti-tracking settings are no longer sufficient.

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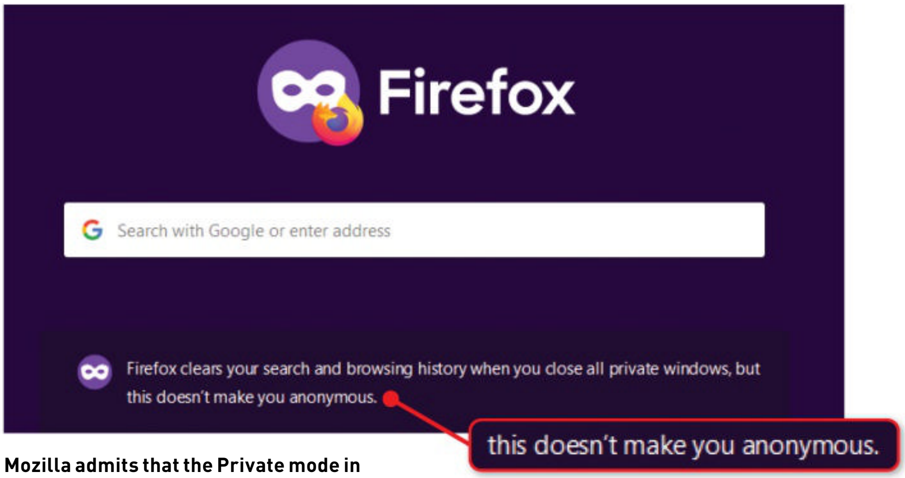
FIVE BROWSER-PRIVACY MYTHS BUSTED



Firefox clears your search and browsing history when you close all private windows, but this doesn't make you anonymous.

this doesn't make you anonymous.

Mozilla admits that the Private mode in Firefox doesn't make you anonymous.

Private-browsing mode makes you anonymous

Your browser's private-browsing mode—called Incognito in Chrome, InPrivate in Edge, and Private in Firefox—is commonly assumed to keep you anonymous online, but it does nothing of the sort. Mozilla actually admits that "this doesn't make you anonymous" (see screenshot right), when you open a new Private tab in Firefox. All private mode does is prevent your browser from storing details of the websites you visit and the terms you search for, and saving temporary files such as cached images and cookies to your PC.

This is useful if you share your computer with someone else, and don't want them to know what you've been doing, but otherwise useless as a means of protecting your privacy. Websites, search engines, advertisers, and your internet service provider (ISP) can still identify you and collect your data—though you can at least stop third-party cookies tracking you across the web.

One exception is the 'Private mode with Tor' option in Brave, which hides your IP address by connecting you to websites via the Tor network, but even this doesn't keep you completely anonymous.

Tell websites not to track you

All browsers include the option to send websites a 'Do Not Track' request, but this is notoriously ineffective because sites simply ignore the request. Chrome's support page states: "Most websites and web services, including Google's, don't change their behavior when they receive a Do Not Track request", and concedes that sites "will still collect and use your browsing data", including for advertising purposes.

Privacy groups hope a new system called Global Privacy Control (GPC) will succeed where Do Not Track has failed by telling websites you don't want your data to be collected and shared, and making this legally binding. Brave and Firefox now enable GPC by default, but—until the system is enforced by local privacy laws—sites aren't obliged to honor it. See www.globalprivacycontrol.com for more.

Blocking cookies stops you being tracked

In the last few years, web browsers have ramped up efforts to prevent cookies from following you around the web. Firefox now enables Total Cookie Protection by default to stop cookies tracking you from site to site. Edge's 'Tracking prevention' has a Strict mode that 'blocks a majority of trackers from all sites', and Brave lets you 'aggressively' block ads, trackers, and cross-site cookies (or all cookies, if you prefer).

Although this extra protection against invasive cookies is welcome, it won't prevent tracking altogether. Websites and advertising companies are increasingly using other methods to identify and follow you, such as fingerprinting, which combines data, including your IP address, browser settings, and the hardware and software you use, to build a profile of you.

Google is planning to phase out cookies in Chrome by the end of 2024 in favor of its new Topics system, which will show you adverts based on your browsing history and activity rather than unique identifiers. Google claims this is better for your privacy, but it will also make cookie-blocking even less effective at tracking prevention.

DNS-over-HTTPS hides your web activities

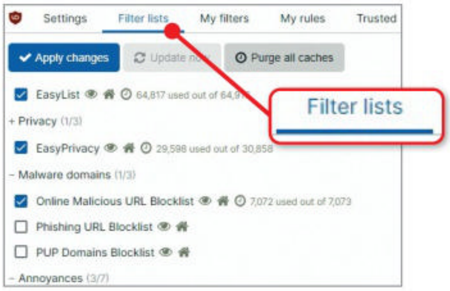
DNS-over-HTTPS (DoH) is a relatively new privacy feature that encrypts the DNS requests your browser makes when you access websites. This should prevent your ISP from identifying the sites you visit, but in practice it's far from reliable.

Although DoH's encryption stops your data being leaked to third parties, your IP address and the IP addresses of sites you connect to remain visible to your ISP, so it knows exactly where you go online. Additionally, DNS-over-HTTPS routes your traffic through a central service—most commonly Cloudflare—which logs all DNS requests. If that service is hacked or breached, your data could be compromised. While DNS-over-HTTPS is worth enabling in your browser, you shouldn't assume it will hide details of all your activities from prying eyes.

More privacy add-ons equal more privacy

We love recommending new extensions for blocking trackers, ads, and snoopers, but installing too many can have an adverse effect on your privacy. Not only will it slow your browser by consuming lots of memory, the combination of add-ons makes it easier for websites to 'fingerprint' you, so they can target you with ads when you visit.

Many of the most popular privacy extensions offer similar features, which means there's no benefit to installing more than a couple. Our favorite, uBlock Origin (www.ublockorigin.com), blocks all manner of online intrusions and annoyances, and you can configure its filters (see below) to block even more. Over the next few pages, we recommend new privacy tools that save you having to overload your browser.



☑ EasyList 64,817 used out of 64,9

+ Privacy (1/3)

☑ EasyPrivacy 29,598 used out of 30,858

– Malware domains (1/3)

☑ Online Malicious URL Blocklist 7,072 used out of 7,073

☐ Phishing URL Blocklist

☐ PUP Domains Blocklist

– Annoyances (3/7)

Filter lists

uBlock Origin offers plenty of ways to block onaline trackers and intrusive annoyances.

© MOZILLA, uBLOCK

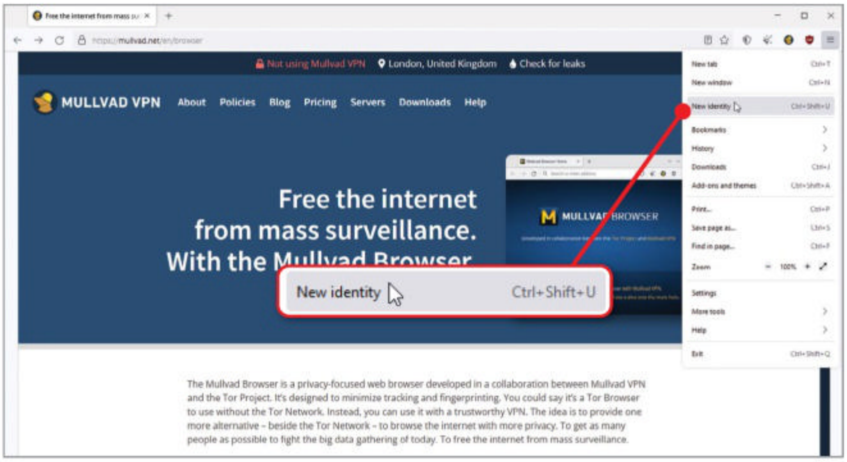
SWITCH TO A NEW PRIVATE BROWSER

Combine Tor and a VPN with Mullvad Browser

The most effective way to be invisible online is to combine a VPN service, which hides your IP address and encrypts all your data, with the Tor Browser (www.torproject.org), which connects you to websites through a series of encrypted 'relays' around the world. This double layer of encryption and location-spoofing ensures nobody can tell who or where you are, or what you're doing—which means you can access geo-blocked content, too.

The main drawback to this combination, which is known as 'Onion over VPN' ('Tor' being short for 'The onion router'), is that it significantly slows your browsing. Tor Browser is designed to let you access sites on the Tor network, which have 56-character onion addresses and constitute what's commonly referred to as the 'dark web' or 'darknet'. Despite the dark web's shady reputation, some of these onion URLs are private versions of reputable news sites that allow people in countries where the internet is censored to view and share information. But because of the roundabout way Tor works, it takes longer to load standard—or 'clearnet'—websites than other browsers, and this is made even slower when it's run through a VPN server.

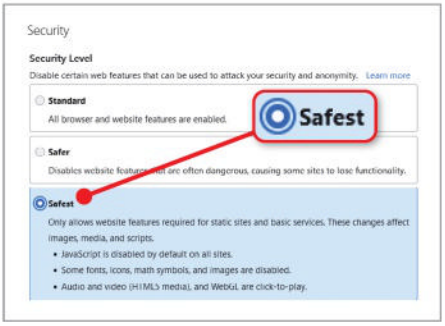
To address the needs of web users who want the anonymity offered by Tor, but aren't interested in accessing dark websites, the Tor Project has teamed up with VPN company Mullvad to create the Mullvad Browser (www.mullvad.net/en/browser). It describes this as "Tor Browser without the Tor Network" for when "a VPN is not enough", and is packed with privacy features to make you invisible online when combined with a VPN. These include protection against fingerprinting; a 'New identity' option that instantly closes all tabs and clears your browsing data to let you start afresh; and a choice of security levels—the strictest of which, Safest (see screenshot below left), only allows essential website features and blocks everything else.



Free the internet from mass surveillance. With the Mullvad Browser

The Mullvad Browser is a privacy-focused web browser developed in a collaboration between Mullvad VPN and the Tor Project. It's designed to minimize tracking and fingerprinting. You could say it's a Tor Browser to use without the Tor Network. Instead, you can use it with a trustworthy VPN. The idea is to provide one more alternative – beside the Tor Network – to browse the internet with more privacy. To get as many people as possible to fight the big data gathering of today. To free the internet from mass surveillance.

Mullvad Browser makes you invisible online when used in tandem with a VPN.



Security

Security Level

Disable certain web features that can be used to attack your security and anonymity. Learn more

○ Standard

All browser and website features are enabled.

○ Safer

Disables website features that are often dangerous, causing some sites to lose functionality.

● Safest

Only allows website features required for static sites and basic services. These changes affect images, media, and scripts.

- JavaScript is disabled by default on all sites.
- Some fonts, icons, math symbols, and images are disabled.
- Audio and video (HTML5 media), and WebGL are click-to-play.

Mullvad's Safest security level blocks everything except essential website features.

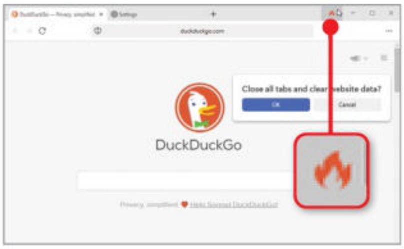
Mullvad Browser's default search engine is DuckDuckGo, and it comes with uBlock Origin installed to block ads, trackers, and third-party cookies from the outset, while browser settings that could compromise your anonymity are excluded or disabled. It's based on Firefox, so you can install extensions from the Mozilla Add-ons Store, but this isn't advisable (or necessary) if you want to remain invisible.

You can use Mullvad Browser with any VPN—not just Mullvad's own VPN, which costs $5.50 per month—to keep your identity and data private as you browse the web. It can be used without a VPN, but this won't mask your IP address or stop your ISP seeing which sites you visit. Unlike Tor Browser, your connection won't be slowed to a crawl or refused by websites that block Tor, because you access sites directly rather than being routed through a series of relays.

Try DuckDuckGo's private browser

We've long been fans of the DuckDuckGo Private Browser for Android (on Google Play Store) and iOS (on Apple App Store), which lets you search and browse the web anonymously by blocking hidden trackers and using encrypted HTTPS by default. The browser is also available for Windows PCs (a Mac version was released last year), but at the time of writing it's still in beta, so you need to join a waiting list to try it.

To do so, install the DuckDuckGo mobile app by tapping the three-dot menu in the top-right corner and choosing Settings, followed by DuckDuckGo Windows App. Select 'Join the Private Waitlist' to request an invite code. Download the PC browser from www.duckduckgo.com/windows, run the installer, and enter the code.



DuckDuckGo's new PC browser lets you clear your browsing data with one click.

Privacy features in the DuckDuckGo browser include blocking all tracking requests and cookie-consent pop-ups (while allowing essential cookies); enabling Global Privacy Control (see page 51) by default so participating sites don't collect and share your data; and letting you instantly close all tabs and clear your browsing data by clicking the Fire button (see screenshot above).

More options are set to be added when DuckDuckGo officially launches the Windows browser later this year. Hopefully these will include Email Protection, which shields your inbox from scammers and spammers by allowing you to sign up with websites using an '@duck.com' address. This forwards messages to your real email and removes all trackers. It's already available in the mobile browser and for your current desktop browser by installing the DuckDuckGo Privacy Essentials extension (www.duckduckgo.com/email). DuckDuckGo's PC browser doesn't let you install extensions.

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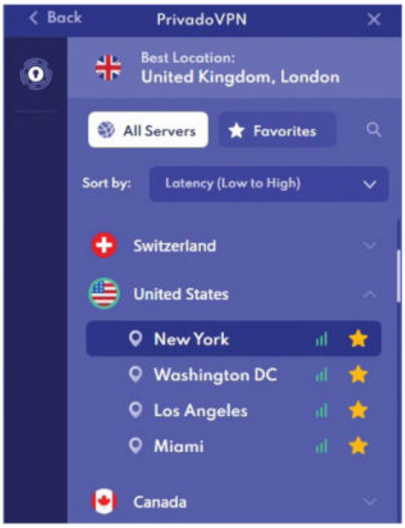
STAY ANONYMOUS WITH A NEW VPN



< Back PrivadoVPN ✕

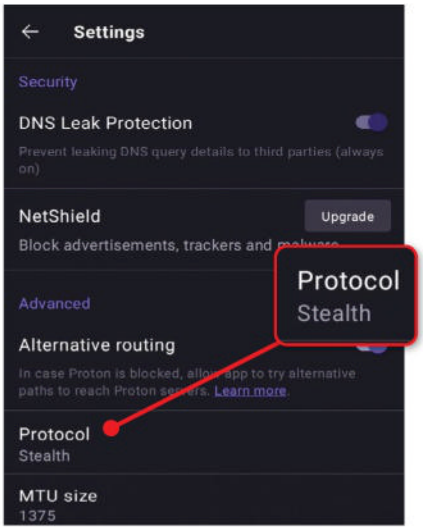
Best Location: United Kingdom, London

All Servers | Favorites

Sort by: Latency (Low to High)

- Switzerland
- United States
  - New York
  - Washington DC
  - Los Angeles
  - Miami
- Canada

PrivadoVPN's free plan offers 12 server locations, including four in the US.



Settings

Security

DNS Leak Protection

Prevent leaking DNS query details to third parties (always on)

NetShield — Upgrade

Block advertisements, trackers and malware

Advanced

Alternative routing

In case Proton is blocked, allow app to try alternative paths to reach Proton servers. Learn more.

Protocol

Stealth

MTU size

1375

ProtonVPN's new Stealth protocol disguises that you're using a VPN.

Become invisible for free with PrivadoVPN

We recommend ExpressVPN and NordVPN as the two of the best VPN services around for most users. But with their monthly subscriptions priced at $8.32 and $11.99 respectively, both options are still relatively expensive, so you may want a cheaper, but still reliable, alternative to help make you invisible online.

One option is PrivadoVPN, which has an excellent free plan (www.privadovpn.com/free-vpn) that our sister website TechRadar rated the best free VPN for 2023 (www.techradar.com/vpn/best-free-vpn). It encrypts up to 10GB of your browsing data each month, and places no limit on your connection speed. You can choose from 12 server locations in 10 countries, which might not sound like much compared with paid-for VPNs (ExpressVPN covers 94 countries), but as these locations include the US (which has four servers—see screenshot above), UK, France, Germany, and Canada, they'll be enough for most.

PrivadoVPN is based in Switzerland, so is outside the jurisdiction of the Fourteen Eyes surveillance alliance, and has a no-logs policy, so it won't collect or share data.

The free plan offers a choice of three VPN protocols and a 'kill switch' (see screenshot right) that halts internet traffic when you lose connection to a server, so you're never left unprotected. It also has a split-tunneling feature (called Smart Route) you can use to exclude apps from VPN encryption; and lets you use PrivadoVPN by installing its apps. It can also unblock some US streaming services, including Netflix and HBO Max.

On the downside, PrivadoVPN's free option only lets you connect one device at a time to a VPN server—for 10 simultaneous connections, unlimited data, and access to more than 300 servers in 63 locations, you need to upgrade to a paid-for plan. This costs $4.99 a month if you pay annually, or $7.99 for one month's use, and includes extra features such as ad blocking and malware protection. However, we suggest trying the free version so you can see how it works and if it fulfils your privacy needs.

Windows Security detected a low-risk threat in the PrivadoVPN download, but this is a false positive caused by the traffic-managing nature of the program (NordVPN once triggered a similar warning), so it's safe to choose 'Allow on device' to let it through.

Activate ProtonVPN's new privacy features

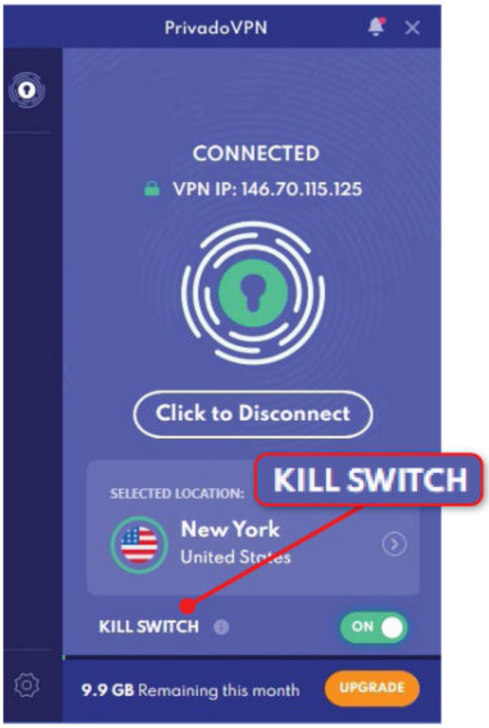
ProtonVPN's free plan (www.protonvpn.com/free-vpn) gives you unlimited bandwidth each month, though it only has servers in three countries: the US, Japan, and the Netherlands. Its VPN Plus plan costs $10 a month, or $8 a month annually, but it has added several new features that make it better value for money.

In April, ProtonVPN introduced extensions for Chromium and Firefox browsers, which make it easier to select VPN servers and switch on encryption as you browse the web. Not only does this conceal your IP address, stop sites tracking you, and hide your activities from your ISP, it also lets you access geo-blocked content.

Last October, ProtonVPN added a new Stealth mode to its mobile apps, which makes encrypted traffic look like 'normal' traffic, so nobody (including your ISP) can tell you're using a VPN. This is also available in the Free plan—open Settings, select Protocol, and choose Stealth (see screenshot left). It will be added to the Windows program soon. Nifty.

Additionally, ProtonVPN has improved its NetShield feature, which blocks ads, malware, and trackers. You can now see how many privacy threats have been detected and blocked, and where they come from. To activate this, click the NetShield icon in the side panel, and select 'Block malware, ads & trackers'.

ProtonVPN Plus can be used on up to 10 devices at once, and has over 1,900 VPN servers in more than 65 countries. For complete anonymity, choose a server with an onion icon to route your encrypted data through the Tor network, albeit at the expense of speed.



PrivadoVPN

CONNECTED

VPN IP: 146.70.115.125

Click to Disconnect

SELECTED LOCATION: New York, United States

KILL SWITCH — ON

9.9 GB Remaining this month — UPGRADE

The Kill Switch halts internet traffic whenever you lose connection to a server.

© PRIVADO, PROTON

NEW WAYS TO SEARCH THE WEB PRIVATELY

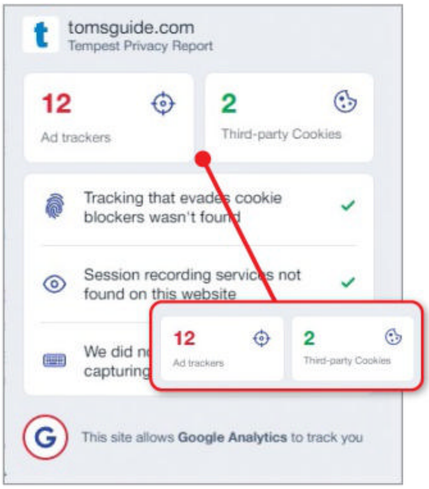
Search without being tracked using Tempest

If you want to search the web without being tracked, profiled, and targeted with ads, there are lots of private alternatives to Google and Bing. The best-known are DuckDuckGo, Startpage, and Brave Search, and now there's another option called Tempest (www.tempest.com).

Launched in March, this doesn't store your search history, implant cookies, or collect personal data. It also encrypts your searches "so prying eyes will just have to pry elsewhere". Unlike Google, its search results are unfiltered to provide "objectively accurate" responses.

When you search for something, it provides a privacy report. Click the shield icon next to the URL to read this, which tells you the number of ad trackers and third-party cookies Tempest has detected (see screenshot), whether the site uses session-recording and keylogging to spy on you; and if it allows you to be tracked by Google Analytics or Facebook. Tempest is supported by adverts, but these are labeled and aren't personalized.

Tempest also has an extension which you can add to Chromium and Firefox, which blocks trackers as you browse the internet, as well as a dedicated Tempest Browser. Unsurprisingly, this uses the search engine by default, but otherwise it's just a standard easy-to-use Chromium browser with a few extra privacy settings.



tomsguide.com
Tempest Privacy Report

12 Ad trackers

2 Third-party Cookies

Tracking that evades cookie blockers wasn't found ✓

Session recording services not found on this website ✓

We did n
capturing

This site allows **Google Analytics** to track you

Tempest lets you search the web privately and detects trackers and cookies

Enjoy ad-free search results with Neeva

Another new private search engine that you might want to consider is Neeva (www.neeva.com), which launched last year. This provides results that are free of ads, trackers, and bias, and promises never to collect or share your personal information. You can also customize your results to include more or fewer pages from specific sources.

The company has been busy recently making a few changes to its product. The search engine is now described as 'AI-powered', though it's not clear how yet, because only certain queries have the effect of triggering an AI response.

Neeva has also introduced a subscription, which was previously only available to users in the US. This costs $4.95 a month, and removes the limits on how many ad-free searches that you can make (free users get 50 a month), and the number of devices you can use your Neeva account on. However, you can still search for free without needing to sign up and pay.

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techradar.com

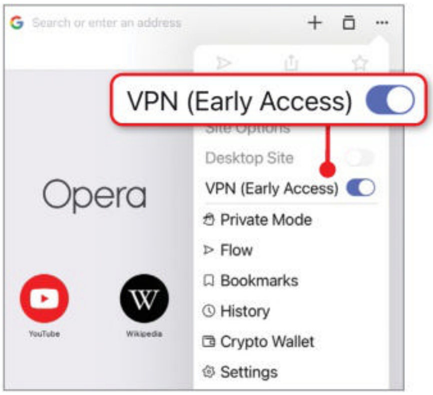
STAY ANONYMOUS WITH A NEW VPN

Use Opera's free VPN on all your devices

The VPN built into Opera (www.opera.com) saves you having to install a separate extension, and is free to use, with no monthly data limit or subscription. It offers servers in three 'general locations'—Americas, Asia, and Europe—so you can hide your IP address from sites you visit.

In April, Opera added the VPN to its iOS app (available on Apple App Store)—it was already available in the desktop and Android browsers. To activate it on your iPhone or iPad, tap the menu button in the app, switch on 'VPN (Early Access)' (see screenshot right), and allow Opera to add a new VPN configuration. Tap the VPN option next to the browser's address bar to connect to a server.

Technically, the free Opera VPN is a proxy service, so it only encrypts data within the browser. To encrypt all internet traffic across your system, you need the VPN Pro plan, which costs $4.99 a month, offers more than 3,000 servers worldwide, and covers up to six devices.



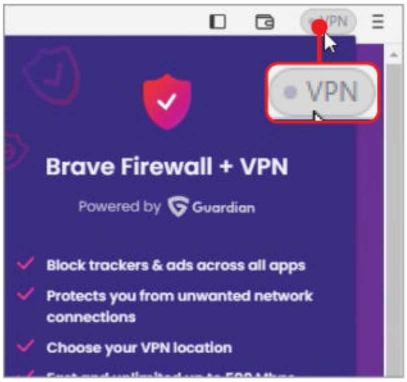
Opera recently added its free VPN to the iOS version of its browser.

Try Brave's new built-in VPN and firewall

Brave is our favorite privacy browser thanks to its Shields feature, which blocks adverts, trackers, and fingerprinting, its 'private mode with Tor', and handling of cookies. In March, it boosted its privacy and security by adding a VPN to its desktop program—you could already use the option in its Android and iOS apps.

Brave's VPN (www.brave.com/firewall-vpn) encrypts everything you do online across your entire device—not just within the browser—so even your ISP can't monitor your activities. It also comes with a firewall that protects you from malware and hackers. Although the service is now integrated with the browser—click the VPN icon next to the menu button (see screenshot below) to launch it—it costs $9.99 a month following a seven-day free trial. Annoyingly, this requires you to enter your payment details upfront.

A subscription protects up to five devices, but the VPN lacks the features and flexibility of rival services (it's curiously vague about its number of servers), so you may prefer PrivadoVPN's free plan.



Brave Firewall + VPN

Powered by Guardian

- ✓ Block trackers & ads across all apps
- ✓ Protects you from unwanted network connections
- ✓ Choose your VPN location

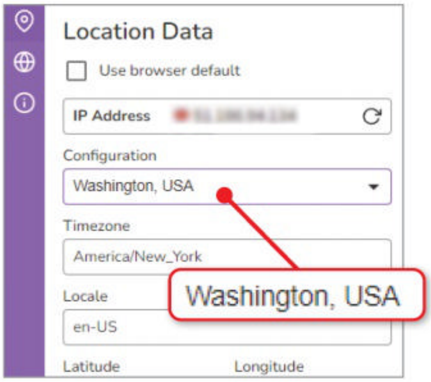
Brave now has a built-in VPN, but you need to pay to use the service.

Prevent fingerprinting by faking browser data

Some websites are able to foil the anti-fingerprinting techniques used by privacy tools and detect you're using a VPN to spoof your location. A new extension for Chromium browsers called Vytal offers extra protection by faking the data sites use to identify you, like your location, time zone, and device.

Install Vytal through the Chrome Web Store, click its toolbar button, and untick the 'Use browser default' box. Click the Configuration dropdown menu, and choose a location to pretend to be in—from Auckland, New Zealand to Washington, USA (see screenshot below middle). If you're using a VPN, select 'Match IP Address' to apply settings that match your VPN server (Vytal itself doesn't hide your IP address). Click the User Agent globe icon to fake your device details so you appear to be using a phone, tablet, or Chromebook.

Unlike other fingerprinting-prevention tools, Vytal doesn't stop sites working, but it does display a 'Vytal started debugging this browser' message to indicate that it's working—click Cancel to close this.



Location Data

☐ Use browser default

IP Address

Configuration: Washington, USA

Timezone: America/New_York

Locale: en-US

Latitude

Longitude

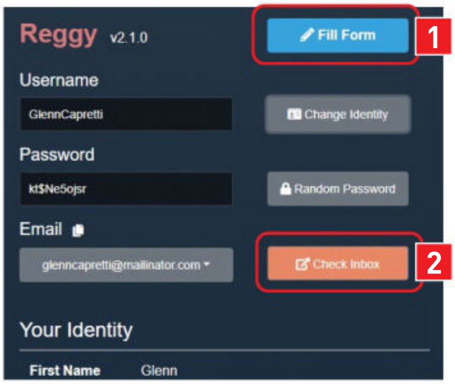
Vytal prevents fingerprinting by faking the data sites use to identify you.

Sign up with websites using a fake identity

One of the biggest obstacles to being invisible online is having to provide your name and email address—and sometimes other personal data—when you register with websites. You can keep this info private using a new Chromium extension called Reggy, which generates random identities for signing up with sites.

Install Reggy through the Chrome Web Store, click the toolbar button, and the add-on will suggest a fake username and password, and extra details including date of birth, address, and phone number, which you can enter in a website's registration form by clicking Fill Form (1 in our screenshot below). Reggy only suggests US contact data, but this shouldn't matter for most users, unless a site requires you to have a local address.

Reggy also gives you a disposable email address from services including Maildrop and Mailinator, so you don't need to provide your real one. Click 'Check Inbox' 2 to access account-verification messages sent to your fake address.



Username: GlennCapretti

Password: kt$Ne5ojsr

Email: glenncapretti@mailinator.com

Your Identity

First Name: Glenn

Reggy creates instant fake identities to disguise your real details online.

© BRAVE, OPERA, VYTAL, REGGY

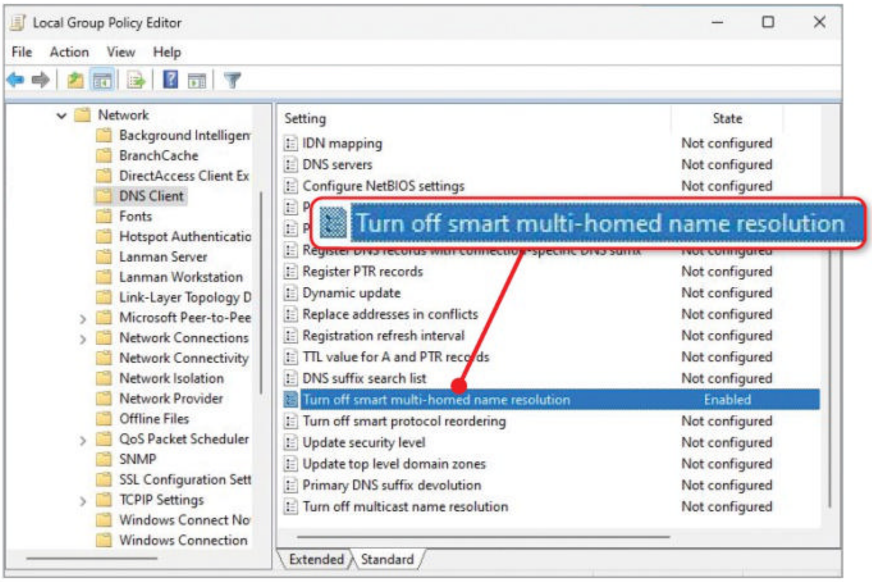
FIVE PRIVACY SETTINGS YOU MUST CHANGE

Turn off Smart Multi-Homed Name Resolution

When Brave launched its VPN, it stressed the importance of disabling an obscure Windows feature called Smart Multi-Homed Name Resolution to ensure you're completely invisible online. This can reportedly expose details of your DNS queries—meaning the sites you visit and servers you connect to—to outside observers, even when you're using a VPN. The problem affects all VPNs on PCs with Smart Multi-Homed Name Resolution enabled, though mainly relates to internet activity outside of VPN-protected browsers.

You can switch off Smart Multi-Homed Name Resolution in Windows 10 or 11 via the Group Policy Editor, though you'll need to be running a Pro edition. If you are, press the Windows key+R, type gpedit.msc into the Run box, and press Enter to launch Group Policy Editor. Open the Computer Configuration list, followed by Administrative Templates then Network and select DNS Client. Double-click the 'Turn off smart multi-homed name resolution' setting (see screenshot above right), choose Enabled, then click OK. This will disable Smart Multi-Homed Name Resolution, and make all your DNS requests totally private.

To tweak the setting in Windows 10 or 11 Home, install Policy Plus—visit github.com/Fleex255/PolicyPlus/releases, open the top set of Assets, and click 'PolicyPlus.exe'. Download and open the required policy definitions when prompted, then click the Find menu. Choose 'By Text', and search for Turn off smart multi-homed name resolution. Select that entry, click Go, and choose Enabled followed by OK.


Local Group Policy Editor
File
Action
View
Help
Extended
Standard
Turn off smart multi-homed name resolution

- Network
  - Background Intelligen
  - BranchCache
  - DirectAccess Client Ex
  - DNS Client
  - Fonts
  - Hotspot Authenticatio
  - Lanman Server
  - Lanman Workstation
  - Link-Layer Topology D
  - Microsoft Peer-to-Pee
  - Network Connections
  - Network Connectivity
  - Network Isolation
  - Network Provider
  - Offline Files
  - QoS Packet Scheduler
  - SNMP
  - SSL Configuration Sett
  - TCPIP Settings
  - Windows Connect No
  - Windows Connection

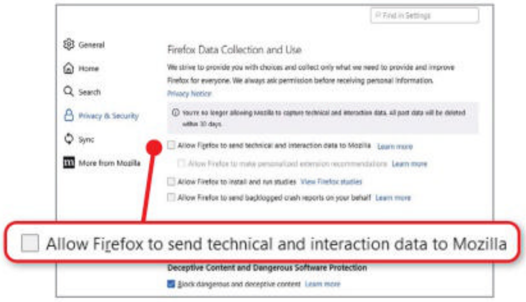
Setting	State
IDN mapping	Not configured
DNS servers	Not configured
Configure NetBIOS settings	Not configured
P	
P	
Register DNS records with connection-specific DNS suffix	Not configured
Register PTR records	Not configured
Dynamic update	Not configured
Replace addresses in conflicts	Not configured
Registration refresh interval	Not configured
TTL value for A and PTR records	Not configured
DNS suffix search list	Not configured
Turn off smart multi-homed name resolution	Enabled
Turn off smart protocol reordering	Not configured
Update security level	Not configured
Update top level domain zones	Not configured
Primary DNS suffix devolution	Not configured
Turn off multicast name resolution	Not configured

Turn off Smart Multi-Homed Name Resolution to prevent DNS data leaks.

Disable Mozilla's data collection in Firefox

Mozilla has made impressive efforts to increase the privacy of Firefox users, such as introducing Enhanced Tracking Protection, which automatically blocks third-party trackers, and Total Cookie Protection, which stops cookies following you from site to site. But the browser itself uses telemetry to collect information about you—including your IP address, operating system, and hardware configuration—to improve performance and stability, recommend extensions, and "allow Firefox to install and run studies".

In fairness, Mozilla is transparent about this data collection, and gives you the option to opt out if you're uncomfortable with it. Click the Firefox menu button and choose Settings, then 'Privacy & Security'. Scroll down to 'Firefox Data Collection and Use' and untick all the boxes, especially 'Allow Firefox to send technical and interaction data to Mozilla' (see screenshot below left). To see what data has already been collected, type about:telemetry into the browser's address bar, and press Enter. Once telemetry is disabled, this data will be deleted after 30 days.



Firefox Data Collection and Use

We strive to provide you with choices and collect only what we need to provide and improve Firefox for everyone. We always ask permission before receiving personal information.

ⓘ You're no longer allowing Mozilla to capture technical and interaction data. All past data will be deleted within 30 days.

☐ Allow Firefox to send technical and interaction data to Mozilla

☐ Allow Firefox to make personalized extension recommendations

☐ Allow Firefox to install and run studies

☐ Allow Firefox to send backlogged crash reports on your behalf

☐ Allow Firefox to send technical and interaction data to Mozilla

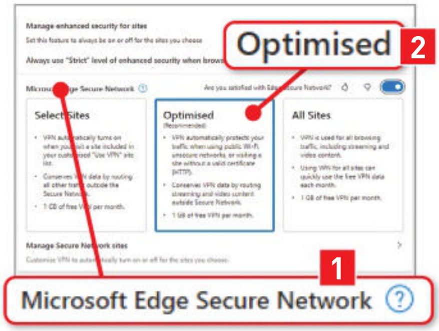
Deceptive Content and Dangerous Software Protection

☑ Block dangerous and deceptive content

Switch off data collection to stop Firefox compromising your privacy.

Turn on Edge's new VPN—if you have it

Microsoft has been testing a basic built-in VPN in its Edge browser for the past year, and by the time you read this it may finally be available. We were able to use the feature, which is called Secure Network and powered by Cloudflare, in the beta version of Edge 113—the stable release is scheduled for the beginning of May. However, Microsoft has a habit of rolling out new tools to some users and not others, so you may not have the VPN yet.



Manage enhanced security for sites

Set this feature to always be on or off for the sites you choose

Always use "Strict" level of enhanced security when brows

Microsoft Edge Secure Network

Select Sites

Optimised (Recommended)

All Sites

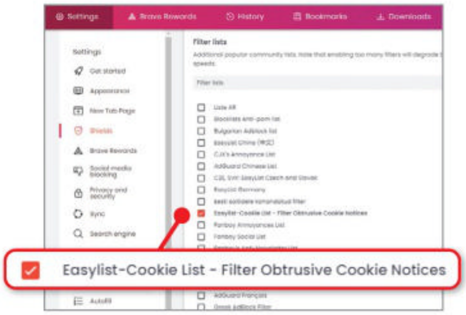
Manage Secure Network sites

Check Edge's settings to see if the browser's new VPN is available to you.

To find out, sign into your Microsoft account, click the browser's menu button, select Settings, then 'Privacy, search and services'. Scroll down to the Security section and look for a new setting called Microsoft Edge Secure Network (**1** in our screenshot above). If it's there, switch it on and select a level of VPN protection.

The 'Select Sites' option only activates the VPN on specific websites, while All Sites applies its protection to all your browsing traffic. However, because Microsoft only gives you a measly 1GB of free data a month, the best option is Optimised **2**, which automatically encrypts your connection when you use public Wi-Fi or access potentially unsafe HTTP sites, but not when you stream content, which uses a lot of data.

© MOZILLA, MICROSOFT



☑ Easylist-Cookie List - Filter Obtrusive Cookie Notices

Brave can block cookie banners without you agreeing to privacy policies.

Edge lets you set Secure Network as your default VPN, but we wouldn't advise doing so at this early stage, especially when much better options are available. As with Opera's VPN, it's really a proxy, and doesn't offer a choice of servers. However, it's still useful if you need instant protection when using a PC away from home, saving you the trouble of installing a separate VPN.

Block all cookie consent pop-ups in Brave

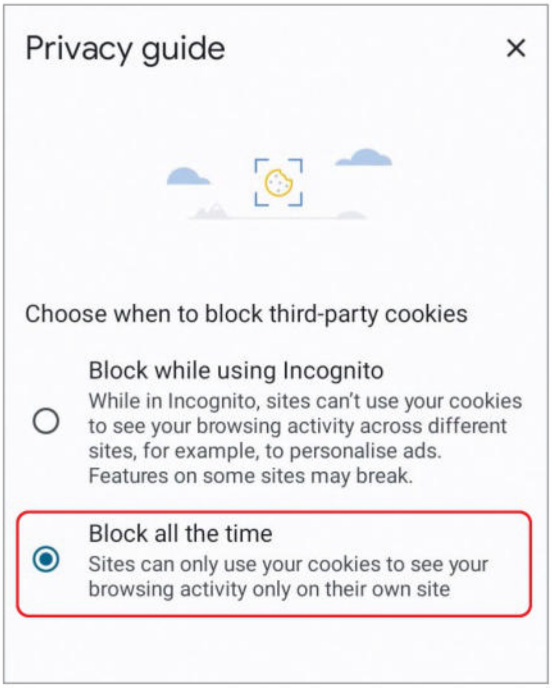
Last October, Brave added a useful privacy option that automatically blocks cookie consent pop-ups on websites. Rather than merely hide these banners and agree to a site's privacy policy in the background—which effectively allows it to collect whatever data it wants—the feature distrusts them by default, so no cookies are planted on your PC without your permission or knowledge. Brave says this is because some sites deliberately ignore your preference, and continue to track you if you interact with their consent pop-ups.

To activate the new option, click Brave's menu button and choose Settings, then Shields. Select 'Content filtering', click 'Show full list' and tick the box next to 'Easylist—Cookie List' (see screenshot above) to dismiss obstructive cookie notices. This saves you needing to install the popular extension I Don't Care About Cookies, though you can add that tool's extensive filter list to block consent pop-ups that Brave misses.

To do so, type the following into the 'Add custom filter list' box and click Add: www.i-dont-care-about-cookies.eu/abp.

Review your privacy settings in Chrome

Compared with other browsers, Chrome has added few new privacy settings in the last year, presumably because Google is planning to change the way it lets sites track you, as part of its Privacy Sandbox initiative. You can opt into or out of the Privacy Sandbox trial by opening the browser's Settings and choosing 'Privacy and security' then Privacy Sandbox.



Privacy guide ✕

Choose when to block third-party cookies

○ Block while using Incognito
While in Incognito, sites can't use your cookies to see your browsing activity across different sites, for example, to personalise ads. Features on some sites may break.

● Block all the time
Sites can only use your cookies to see your browsing activity only on their own site

Review and boost Chrome's privacy settings through its Privacy Guide.

A year ago, Google announced a feature called Privacy Guide (blog.google/products/chrome/take-step-step-guide-your-chrome-privacy-settings/), which provided a step-by-step tour of Chrome's privacy settings so you could decide how much data you shared. This was supposed to appear in Chrome 100, but it either never arrived or was removed, so you'll need to find and tweak settings individually.

However, you can still use Privacy Guide in the Android version of Chrome. Type chrome://flags into the address bar of the app, and press Enter to access the Experiments page. Search for Privacy Guide on Android, select Enabled in its dropdown menu, and relaunch the browser. Et voilà!

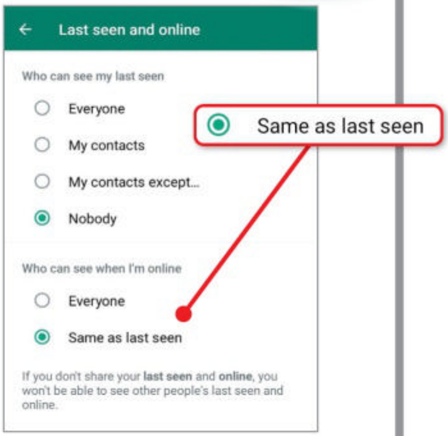
When Chrome reopens, tap the three-dot menu button in the top-right corner, choose Settings, then 'Privacy and security'. Select 'Privacy guide' and tap 'Let's go' to review your preferences. You can opt out of sharing details of sites you visit with Google, stop your browsing history being synced across devices, and even block third-party cookies all the time (see screenshot above). Hopefully this helps you feel more private online.

Make yourself invisible on WhatsApp

WhatsApp has added several new features in the last year that make you invisible—not from companies that want to collect your data, but from other people. For example, you can hide the fact that you're online, so you don't get bothered with messages at inconvenient times.

To do so, open Settings in the app and tap Privacy. Press 'Last Seen & Online' and, in the 'Who can see my last seen' section, choose either Nobody, to be invisible to everyone, or 'My contacts except…' to select people to hide your last-seen status from. Choose 'Same as last seen' (see screenshot) under 'Who can see when I'm online' to apply the same setting to your active online status.

You can also hide your profile photo and About information from other people. Tap 'Profile photo' on the Privacy screen, and again choose either Nobody or 'My contacts except..'. Do the same for About, and you'll be able to use WhatsApp much more privately.



← Last seen and online

Who can see my last seen
○ Everyone
○ My contacts
○ My contacts except...
● Nobody

Who can see when I'm online
○ Everyone
● Same as last seen

If you don't share your last seen and online, you won't be able to see other people's last seen and online.

● Same as last seen

© BRAVE, GOOGLE, WHATSAPP

CENTERFOLD

PERFORMANCE GEAR LAID BARE

1 SCREEN

The IPS-level 1080p screen is as punchy as you could hope for. The FullHD resolution makes it pin-sharp, with none of the fuzziness you get from even the top-end Steam Deck panel, while the Windows desktop is actually usable, too.

2 CONTROLS

Below the controller view are Armoury Crate buttons. You can select performance modes, toggle the real-time system monitor overlay, and access the FPS limiter, AMD RSR toggle, and other quick settings.

3 COOLING

The twin fans of the Asus machine keep it cool, and do so quietly. The noise of the Deck made it uncomfortable to use in polite company, but the ROG Ally is mostly quiet, only really audible in Turbo mode. Even then, it's never noisy.

Asus ROG Ally

IT'S NO EXAGGERATION to say that the next generation of handheld gaming PCs has arrived in the form of the ROG Ally. It builds on what the Steam Deck achieved to make a really good portable PC gaming experience.

That's because the top-end ROG Ally, with its AMD Z1 Extreme chip, is priced at just $699. Performance is what sets it apart from Valve's handheld, though. That AMD Z1 Extreme APU is a stunning piece of mobile silicon, with a CPU heart capable of outstripping modern Alder Lake Core i5 and Core i7 processors. That, along with its surfeit of DDR5 memory and PCIe 4.0 SSD, makes it a supremely responsive system.

The 12 CU RDNA 3 GPU is also impressive for an integrated GPU. Native 1080p gaming is possible if you drop what you're playing down to medium or low settings. That applies to handheld and dock mode too, meaning the ROG Ally produces a fine games console experience. By pricing it just $50 more than the 512GB Steam Deck, Asus has effectively rendered the top spec Deck obsolete.

It's not without issues, however, chief of which is the poor battery life. This is the only part of the picture where it feels like Asus has missed the mark, delivering gaming laptop-level battery life that isn't quite good enough in a genuine handheld. **–GUY COCKER**

SEVEN THINGS YOU NEED TO KNOW ABOUT WI-FI

Another new wireless technology, already? *Darien Graham-Smith* looks ahead to the next-generation networking standard

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1 IT'S RIGHT ON SCHEDULE

If you're not ready for Wi-Fi 7, that's understandable. Most of us haven't caught up with Wi-Fi 6E yet, which only hit the mainstream around 18 months ago.

Strictly speaking, Wi-Fi 6E wasn't a new standard. While it introduced support for wireless networking in the 6GHz frequency range, it's otherwise based on the same 802.11ax specification as Wi-Fi 6.

From the original 802.11b release in 1999 onwards, each generation of the technology has reigned for between four and six years, before being replaced by something smarter and faster. Wi-Fi 6 was adopted in 2019 and Wi-Fi 7 is due to be finalized in 2024, so it fits the pattern.

That doesn't mean you'll have to wait until next year to move up to Wi-Fi 7. The core features and technologies are already defined, allowing manufacturers to build and release Wi-Fi 7 hardware well ahead of the final sign-off. Indeed, while Wi-Fi 6 was released in 2019, the standard wasn't fully signed off until February 2021—16 months after we'd reviewed our first Wi-Fi 6 router, the Asus RT-AX88U.

TP-Link's Archer BE900 costs $700.

2 IT PACKS IN DATA MUCH MORE DENSELY THAN PREVIOUS WI-FI STANDARDS

Wi-Fi 7 uses the same OFDMA technology as Wi-Fi 6, which divides up the airwaves according to demand so that multiple devices can smoothly share the available bandwidth.

However, each "slot" carries more data than before, thanks to higher-order QAM (quadrature amplitude modulation). This is used to encode data in a radio signal by adjusting the amplitude and phase of a pair of carrier waves. Different combinations create different wave patterns, which can represent different binary values.

Since the radio waves are analogue, the number of values that can be represented is effectively infinite—the only limitation is how the radio transceiver can modulate and decode waves. Wi-Fi 5 used a 256-QAM system, where each wave pattern encoded eight bits of data, while Wi-Fi 6 increased this to 1,024-QAM, supporting ten bits. The latest Wi-Fi 7 standard boosts this to 4K-QAM, so they can now carry 12.

Wi-Fi 7 also brings upgraded MIMO capabilities, enabling devices to communicate using up to 16 antennas—twice as many as Wi-Fi 6. In practice, we doubt you'll ever see a 16x16 MIMO connection: multiplexing pushes up the cost and complexity of the design, which is why consumer Wi-Fi 6 and 6E devices rarely go beyond 2x2 MIMO.

3 IT HAS TWICE THE BANDWIDTH OF WI-FI 6 AND 6E

Wi-Fi 6 and 6E benefit from fat 160MHz channels. Wi-Fi 7 doubles this again, with the maximum supported channel size going up to 320MHz, increasing the nominal data rate from 1.2Gbits to 2.4Gbits/sec per stream.

This benefit doesn't apply on every radio band. There isn't enough contiguous spectrum within 2.4GHz or 5GHz to accommodate such an enormous data channel.

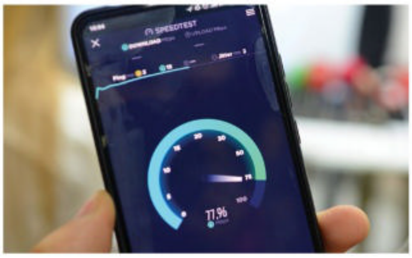
6GHz offers a broad frequency range, stretching from 5.955GHz to 6.415GHz. Wi-Fi 6E can use only a single 160MHz chunk, but with Wi-Fi 7 there's enough for a full-width 320MHz channel—plus a second, non-overlapping 160MHz channel. In the US, available frequencies go up to 7.115GHz, letting three 320MHz channels coexist. Ofcom is considering whether to permit a similar expansion in the UK.

To get the best performance from these ultra-wide channels, Wi-Fi 7 makes use of a feature called preamble puncturing, which allows the router to selectively avoid transmitting on specific frequencies within the 320MHz channel where interference is detected.

4 CONNECT ON MULTIPLE RADIO BANDS AT ONCE

Wi-Fi 7 has introduced a new feature called Multi-Link Operation, or MLO. This lets devices establish multiple simultaneous connections across combinations of the 2.4GHz, 5GHz, and 6GHz frequency ranges.

The ability to aggregate two or three links enables bandwidth to be multiplied. As well as increasing throughput, MLO can provide more reliable connections: using traffic analysis and QoS rules, the router can spot interference, calculate priorities, and decide which frequencies to use for communicating with different clients.



MLO will boost throughput and reliability.

© TP-LINK, PEOPLEIMAGES/ISTOCK/GETTY IMAGES PLUS, SOPA IMAGES/CONTRIBUTOR/GETTY IMAGES

Wi-Fi 7 allows more devices to connect at faster speeds

5

WI-FI 7 ISN'T JUST FASTER, IT'S MORE RESPONSIVE

Most people's wireless networks can already go faster than their internet connection. There's nothing wrong with that—if it were the other way round, you'd be paying your ISP for bandwidth you couldn't use. However, you might be wondering what the point is in introducing even faster wireless.

One answer is that internet connections keep getting faster. In my own testing, I've found that the latest Wi-Fi 6E routers typically transfer data at between 500 and 800MB/sec at short range, falling to around 250Mbits/sec in other rooms. In the next few years, as gigabit and even multi-gigabit broadband lines become cheaper and more widely available, more households are going to find that a Wi-Fi 6 router holds them back.

Remember, too, that not all networking involves the internet. Our homes contain a growing number of smart appliances, which are continually talking to hubs and to one another. While we're storing more and more data in the cloud, domestic NAS systems remain popular for convenient shared storage and bulk archival. The huge bandwidth of Wi-Fi 7 can keep this data flowing swiftly.

There's another factor to consider, too. Wi-Fi 7 doesn't aim only for faster transfers, but also for lower latency. That means it's ready for the incoming age of game streaming and extended reality—both applications that demand a near-instant response to user input.

It's hard to put a figure on the benefit compared to earlier Wi-Fi standards, because real-world latency depends on the environment. What we can say is that a latency of around 10ms has been suggested for Wi-Fi 7, potentially falling as low as 1ms. To put that into context, Nvidia's cloud-based GeForce Now gaming service recommends 40ms or less for an optimal experience, suggesting that any lag from your Wi-Fi 7 router should be unnoticeable. The latency of your internet connection might be another story, of course.

THE WHEN OF WI-FI

The evolution of Wi-Fi standards, from 1999 to the present day

1999
802.11b

The first mainstream Wi-Fi standard, 802.11b operated exclusively on the 2.4GHz band. It offered connection speeds of up to 11Mbits/sec, and could work on any of 13 user-selectable 20MHz channels to avoid interference. The companion 802.11a standard used the faster 5GHz frequency range, but licensing delays and higher manufacturing costs meant it never caught on.

2003
802.11g

The first major Wi-Fi upgrade came four years later and used the same 13 channels as 802.11b, while raising the maximum data rate to 54Mbits/sec. As would become the norm, the specification was designed for backward compatibility with older devices, but if a single 802.11b client was connected to an 802.11g network, it slowed the connection down for everyone.

2008
WI-FI 4 (802.11n)

The 802.11n standard was the first to use QAM, and also the first to bring 5GHz networking into the mainstream, although dual-band support was optional. Other innovations included 40MHz channels and MIMO for downlink connections; in theory, these enabled 802.11n to hit download speeds of 600Mbits/sec, although most consumer routers topped out at 300Mbits/sec. In 2018, 802.11n was rebranded "Wi-Fi 4".

© MASKOT/GETTY IMAGES

6 THE FIRST WI-FI 7 DEVICES ARE ALREADY HERE

If you're eager to get a device with a Wi-Fi 7 logo, you don't need to wait long. Broadcom has been shipping Wi-Fi 7 chipsets since April 2022, and both Qualcomm and MediaTek are offering Wi-Fi 7 solutions.

Two Chinese manufacturers are already offering Wi-Fi 7-enabled smartphones: the OnePlus 11 5G and Xiaomi 13 Pro, which we reviewed last month (see issue 344, p64). However, iPhone fans may need to wait longer, as Apple tends to lag behind when it comes to Wi-Fi.

It's a similar situation with laptops and PCs. Wi-Fi 7 expansion cards will probably appear in the second half of 2023, so custom-built PCs with Wi-Fi 7 are only months away—and existing systems with an accessible PCI-E or M.2 2230 slot should be easily upgradable. Intel says the new networking technology will be standard on Core-powered PCs in 2024.

The new OnePlus 11 5G supports Wi-Fi 7

7 IF YOU WANT TO BUY A WI-FI 7 ROUTER, START SAVING UP NOW

As with all Wi-Fi standards, Wi-Fi 7 devices can connect to older networks, but if you want to get the best performance, you need a matching router—and the first Wi-Fi 7 models on the market are going to be pricey.

One example is Netgear's new Nighthawk RS700, expected to ship in early summer. This distinctive upright router promises a total throughput of up to 19Gbits/sec, with 4x4 MIMO across the 2.4GHz, 5GHz and 6GHz radio bands. It also includes 10Gbits/sec Ethernet for both WAN and LAN ports to support next-generation internet connections and high-speed wired clients. The US RRP is $700.

If that doesn't appeal, TP-Link has announced four Wi-Fi 7 routers and three mesh systems. The lead product is the Archer BE900, which matches the Netgear's $700 price tag, but boasts a cool touchscreen and faster all-bands speed rating of 24Gbits/sec. This is achieved by adding a second 5GHz radio, so previous-generation devices won't interfere with full-bandwidth MLO connections. There are also cheaper tri-band BE800 and BE550 variants, plus a gamer-focused Archer GE800, although pricing hasn't yet been revealed.

On the mesh front, the star of the show is the TP-Link Deco BE95, which offers a bandwidth of 33Gbits/sec, including twin 6GHz radios at 11.5Gbits/sec each. It will be faster than any mesh we've tested—the current titleholder is the Wi-Fi 6E-powered Netgear Orbi RBK963E, which offers an aggregate connection speed of 10.8Gbits/sec across its four radios. The BE95 is also one of the most expensive systems we've seen, at $1,199 for two units. As with the Archer, there are cheaper alternatives—the BE65 and BE85 are rated at 11Gbits/sec and 22Gbits/sec respectively, with pricing and release dates to be confirmed.

Finally, Asus has two initial Wi-Fi 7 offerings. The RT-BE96U matches the Netgear's 19Gbits/sec speed rating and its twin 10GbE ports, while the gaming-oriented ROG Rapture GT-BE98 adds a second 5GHz radio, similar to the TP-Link Archer BE900. Currently there's no release date or pricing for these routers, but watch this space. ⏻

TP-Link's Archer BE900 costs $700

2014
WI-FI 5 (802.11ac)

The adoption of 5GHz networking was slow in the 802.11n era, so the next version of the standard made support mandatory for all clients and gateways. It also defined a new 80MHz channel width, and 256-QAM encoding—a big step up from the 64-QAM used in the previous generation. This enabled connection speeds of up to 867Mbits/sec per stream, or as much as 2.6Gbits/sec for a single client using 3x3 MIMO.

2016
WI-FI 5 (802.11ac) WAVE 2

Two years after the rollout of Wi-Fi 5, the Wi-Fi Alliance unveiled "Wave 2" for Wi-Fi 5 devices that supported a range of enhanced tech. These included a 160MHz channel width and an increase in the maximum MIMO configuration from 3x3 to 4x4. Download speeds as high as 6.8Gbits/sec were now attainable, and Wave 2 also introduced MU-MIMO, allowing multiple devices to enjoy MIMO connections at once.

2019
WI-FI 6 (802.11ax)

Wi-Fi 6 brought a new airtime-sharing system called OFDMA, which allowed multiple devices to interoperate simultaneously with minimal interference. QAM capabilities were again upped to 1024-QAM, and MIMO support was expanded to 8x8 MIMO, enabling a maximum connection speed of 9.6Gbits/sec. Wi-Fi 6 also introduced uplink MIMO for, enabling faster uploads from compatible clients.

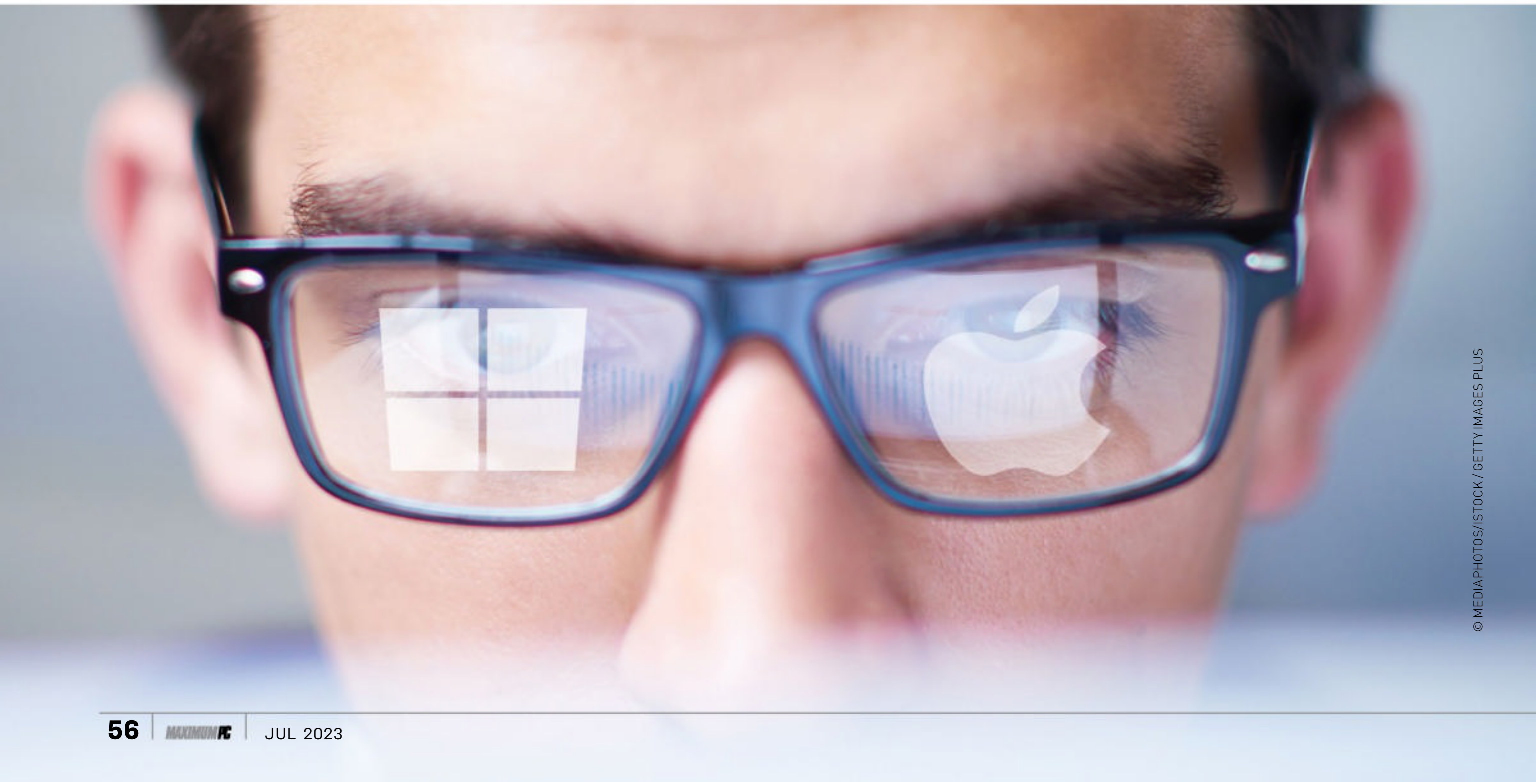
2020
WI-FI 6E (802.11ax)

More a variant than a true standard, Wi-Fi 6E is a version of Wi-Fi 6 that adds support for connections in the 6GHz radio band. Otherwise, the encoding and transmission systems are identical to those in Wi-Fi 6, but reduced interference in the higher frequency range means that 6E devices often achieve better real-world performance than a standard Wi-Fi 6 connection on the 5GHz band.

© ONEPLUS, TP-LINK

RUN WINDOWS AND MACOS TOGETHER

Why limit yourself to one OS? ***Nik Rawlinson*** finds out how to work seamlessly across different platforms



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THE WORLD USED TO be divided sharply into two tribes—you were a Windows person or an Apple person, and that was it. Today, that barrier has all but dissolved. Plenty of people are mixing and matching hardware, working with a range of PCs, Macs, and mobile devices, as suits the context or task at hand. Your choice of computer has never been less important—all that really matters is that you can access and work with your data.

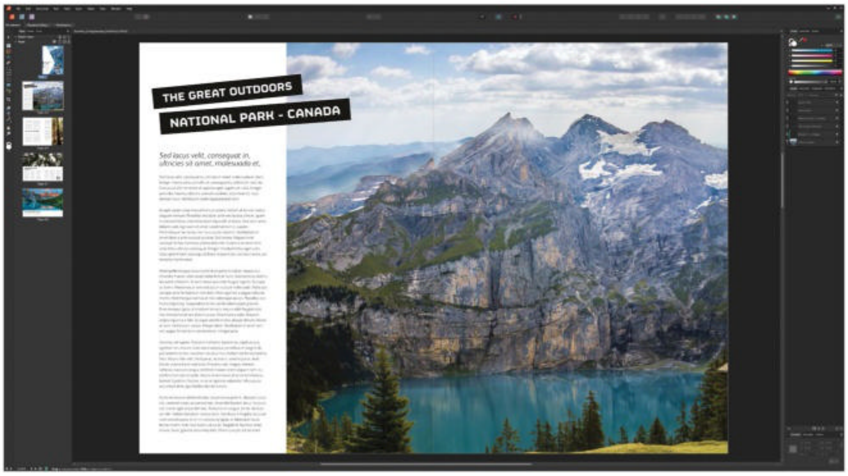
Even in these enlightened times, however, that isn't something you can always take for granted. Different file formats and ways of working can trip you up as you hop between platforms. If you're running Windows and macOS side by side, or working alongside someone on a different platform, here's our rundown of recommendations for working on PCs and Macs together. Most of them can be applied to Linux, too.

Productivity tools

The easiest way to work across platforms is to use an online office suite, such as Google Workspace, Microsoft 365, Zoho Office, or the iCloud versions of Apple's Pages, Numbers, and Keynote applications.

That's not your only option, however. Microsoft Office is available for both Windows and macOS (plus iPadOS), and can conveniently synchronize documents via OneDrive. As a free alternative, LibreOffice also works on the Mac, PC, and Linux, and integrates with cloud storage services such as Google Drive to simplify the process of managing and accessing your documents.

If you don't want to entrust your data to Google, you may prefer to set up your own WebDAV server for convenient document storage and sharing. This can reside on a commercial web host or your own hardware. An easy way to set it up is via the Nextcloud collaboration framework, which is included in the DietPi OS distribution for the Raspberry Pi and other single-board computers (dietpi.com).



Affinity Publisher is a powerful cross-platform page layout suite.

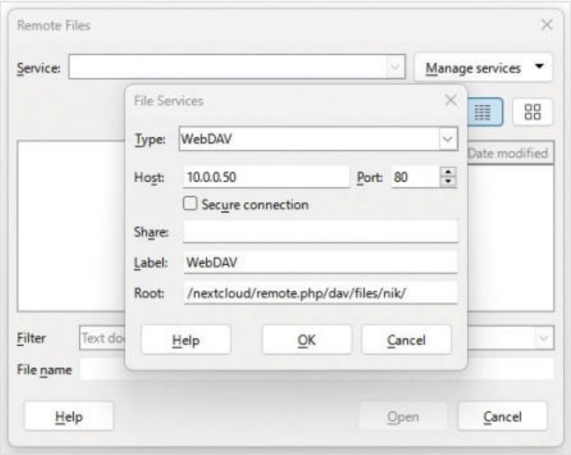
To connect LibreOffice to your WebDAV server, open one of the LibreOffice applications and select File | Open Remote... In the window that opens, click "Manage services" , followed by "Add service"; then, open the Type menu, and select WebDAV from the options.

Now, enter the location of your WebDAV server in the Host field (for Nextcloud, this is the address of your server). In the Root field, enter your user folder's address, which is /nextcloud/remote.php/dav/files/USER/, replacing USER as appropriate.

The first time you establish a remote connection, LibreOffice will ask you to create a master password to protect it. Enter this twice and make sure you remember it for future use. You should only need to enter it once per session.

Plugging the gaps

Things get trickier if you're using apps that are available on only one platform—for example, Microsoft Publisher and Access are missing from Mac editions of Office. If you rely on either, it's worth looking for replacements.



Service:

Type: WebDAV

Host: 10.0.0.50 Port: 80

☐ Secure connection

Share:

Label: WebDAV

Root: /nextcloud/remote.php/dav/files/nik/

Filter Text do

File name

A WebDAV server makes your files accessible from anywhere.

For desktop publishing, Adobe InDesign is the industry standard, but the monthly fee is steep for non-professionals. Affinity Publisher 2, from Serif, is a powerful and affordable solution that works seamlessly across Windows, Mac, and iPad. You can share your work between all three, leaving off on any one of them and picking up again on either of the other two, and it costs a very reasonable $70 for either Windows or Mac—less than the price of four months of InDesign. You can also buy a Universal Licence for the whole Affinity Suite (affinity.serif.com), which includes the Photo and Designer tools for $165, and permits simultaneous installation on Windows, Mac, and iPad.

If you're making the switch, though, be aware that Affinity Publisher 2 can't import Microsoft Publisher files. Anything that's been created in Microsoft Publisher will need to be recreated, or exported as a PDF and edited from there.

As for Microsoft Access, the natural alternative is LibreOffice Base, which is included in the free LibreOffice suite. Although you can't directly open an Access database in LibreOffice Base, there are several ways to migrate your data.

One is to export your databases from Access in XLS format, and import them from there into new LibreOffice databases. Another is to use the Microsoft Access Runtime (tinyurl.com/yw272pvv), which includes the Access Database Engine. This can be used to give access to the data itself, or facilitate its transfer.

Alternatively, the Java-based UCanAccess driver allows JDBC database programs (including LibreOffice Base) to connect directly to Access databases. Find it at ucanaccess.sourceforge.net.

File synchronization

When you're working across multiple devices, the most fundamental requirement is retaining access to all your files. You could use a cloud provider, such as Dropbox, but these only offer limited space unless you pay for a premium service.

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SERVICE	PRICE	MAX MACHINES	CAPACITY
Backblaze Personal Backup backblaze.com	$7 per month $70 per year $130 per 2 years	Unlimited	Unlimited
Carbonite Plus carbonite.com	$30 per year (limited time offer; regular price $120 per year)	One computer (price per computer)	Unlimited
IDrive Personal 5TB idrive.com/uk	Unlimited	Unlimited ("one user, multiple computers")	5TB
Livedrive Pro Suite livedrive.com	$240 per year	5	Unlimited PC and Mac storage; 5TB mobile backup
SugarSync 250GB sugarsync.com	$9.99 per month	Unlimited	250GB

You may prefer to provision your own centralized storage across your local network by repurposing an old computer as a file server, or as a NAS using TrueNAS Core (truenas.com/freenas). This gives you ongoing control and oversight over your shared storage, and complete freedom to expand it over time.

If you don't have any hardware you can recycle, the open-source FreeFileSync tool (freefilesync.org) can be set to watch specified folders and automatically synchronize them across your machines. It's an excellent free alternative to paid-for cloud syncing services, but it doesn't keep cloud copies or older versions of your data, and only works on Windows, macOS, and Linux, with no support for mobile phones or tablets.

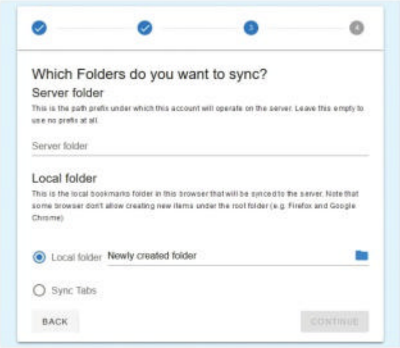
Other synchronization options include Syncthing (syncthing.net), Syncplicity (syncplicity.com), and GoodSync (goodsync.com). If you're already paying for web hosting, you could set up WebDAV in your web space, and make use of any spare capacity you have in your hosting account.

Share your bookmarks

Sharing bookmarks across devices is automatic if you're using the same browser on each platform. But what if you want to use, say, Safari on the Mac, and Edge on your PC?

The answer is a bookmark synchronization add-on such as xBrowserSync (xbrowsersync.org), which allows you to choose where your bookmarks are stored and access them from any device logged into the same account. There are synchronization servers in the UK, Canada, and Germany; for total control of your data, you can install your own xBrowserSync service from Github (github.com/xbrowsersync/api).

If you've already set up Nextcloud or a WebDAV server, you could alternatively try Floccus (floccus.org), which synchronizes bookmarks across your devices while keeping them on your own infrastructure.


Which Folders do you want to sync?

Server folder

This is the path prefix under which this account will operate on the server. Leave this empty to use no prefix at all.

Server folder

Local folder

This is the local bookmarks folder in this browser that will be synced to the server. Note that some browser don't allow creating new items under the root folder (e.g. Firefox and Google Chrome)

● Local folder: Newly created folder

○ Sync Tabs

Floccus synchronizes bookmarks across your devices.

You'll find Floccus add-ons for Firefox, Edge, Chrome, iOS, and Android at floccus.org/download.

Research your backup options

The more devices you use, the more it makes sense to back up to the cloud. This ensures backups are regularly updated, without you having to connect and transport drives between systems.

Most online backup solutions support both Windows and macOS, so it's up to you which you choose. Make sure, though, that whichever you select has space for your data, and allows simultaneous logins from every machine in your arsenal. See above for indicative prices and capacities for five popular options.

Sharing peripherals

If you're using multiple computers on the same desk, you'll want to share peripherals where possible. This can be

SHARING A PRINTER

Many modern printers are designed to serve a whole network, but if your printer only has a USB connection, there are ways to share it across multiple computers. If your router has a USB port, it may have a print server.

If that feature isn't available, you can share a printer from within Windows or macOS. The catch is that the printer will only be available when the computer is powered on and online. You might therefore consider setting up a Raspberry Pi as a dedicated print server: this is a little more complicated than clicking a few buttons, but you'll find full instructions here: (www.tomshardware.com/how-to/raspberry-pi-print-server).

You can share your printer across multiple computers in a variety of ways.

© EUGENIO MARONGIU/IMAGE SOURCE/GETTY IMAGES, FLOCCUS

confusing in some cases: in particular, keyboard layouts are subtly different across Windows and macOS, with the positions of some keys, including @, ", Control/Ctrl, and Alt/Opt varying. You'll find a guide to the differences at tinyurl.com/bdcnmbh7, and details of how to "translate" Windows terms and controls for the Mac at tinyurl.com/5n6js2yy.

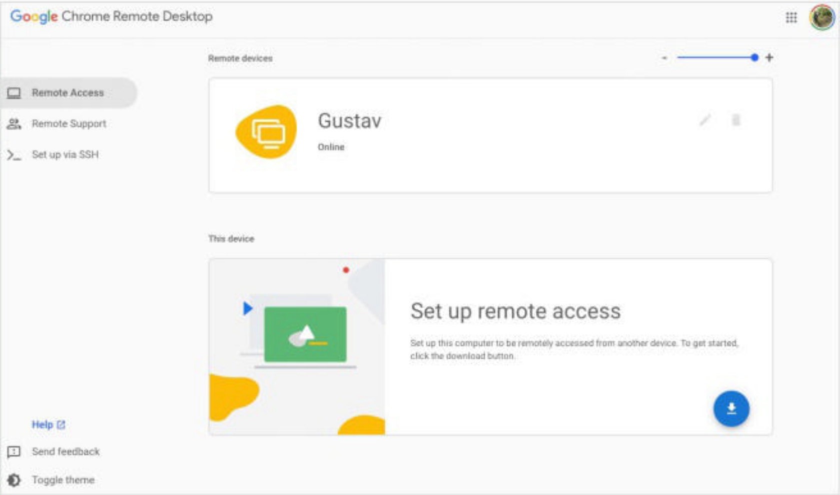
Switching to a multiplatform keyboard such as the Logitech K780 ($80) can help. This wireless keyboard has combined Start/Alt and Alt/Cmd keys to suit different platforms, and can switch between three Bluetooth hosts at the touch of a key, so you can easily share it between PC, Mac, and tablet. The Logitech M720 mouse ($50) can likewise pair with three devices and switch between them as required.

If you want to share a single display across your Mac and PC, you can plug two cables into different inputs at the rear of your monitor. If yours has only a single socket, a HDMI switch is the answer: an entry-level switch capable of supporting two 4K inputs costs less than $10.

If your main computer is an iMac, you won't be able to use it as a display for a Windows laptop; likewise, many all-in-one Windows PCs don't support external video signals. However, there are ways to work around this. If your PC is running a Professional edition of Windows 10 or 11, you can use Microsoft's Remote Desktop tool (tinyurl.com/mtcvdt3s) to access it from the Mac desktop. Connect using your PC's IP address, and your Windows username and password.

To access your Mac from a Windows desktop, open the macOS System Settings (called System Preferences on older versions of macOS), click through to the Sharing pane, and turn on the switch beside Screen Sharing. Click "i", followed by Computer Settings, make sure both tickboxes on the following screen are ticked, and that you've supplied a password. You can use a free VNC client to connect to the Mac across your network.

If these methods don't suit you, another try Chrome Remote Desktop, a free add-on for Chrome-based browsers. Download it from remotedesktop.google.com, and install it on both of your devices.



Set up remote access

Set up this computer to be remotely accessed from another device. To get started, click the download button.

© GOOGLE

Chrome Remote Desktop lets you access one computer from another.

Once the program has installed, you'll be prompted to give each computer a unique name, and create a PIN. Now, when you visit remotedesktop.google.com on one machine, you'll be able to access and use the other one as long as they're logged into the same Google account.

Why not just switch to the web?

Many of the complications of working across multiple platforms can be solved by using web apps. As well as Google Workspace, you can use Adobe Photoshop in a browser (photoshop.adobe.com) and lay out documents using Canva (canva.com). So why do you need to go install software on your local machine?

One possible answer is connectivity. Online software requires a reliable internet connection: slow or patchy broadband makes online working an unsatisfying experience at best.

Web apps are also less customizable than their desktop equivalents. For example, you can't tailor toolbars to place your most commonly used features in prominent positions, resize interface elements, or tweak shortcuts. Native applications may lack the convenience of cloud services, but they almost always provide a better experience. ⏻

EIGHT TIPS FOR THE CROSS-PLATFORM LIFE

1 Where possible, store your data in the cloud or on a NAS appliance, rather than on your local machine, to avoid creating silos.

2 Use open formats, such as the Open Document Format or Microsoft's Office document formats. You can set LibreOffice to use either of these by default, depending on your preference.

3 Standardize on common fonts across all of your documents. Linux users can install Microsoft fonts with `sudo apt install ttf-mscorefonts-installer`. Note that Calibri isn't available on Linux.

4 Ensure external drives (including USB flash drives) are formatted so they can be read and written to by all platforms. The exFAT file system is best for universal compatibility.

5 Implement a robust backup routine and regularly check in with the management interface to make sure your backups are current.

6 Use IMAP for email rather than POP3, so that messages are stored on the server, rather than downloaded to whichever local machine you're using—or stick with webmail.

7 Avoid the inconvenience of dual booting: if you must run two operating systems on one computer, use virtual machines instead.

8 Embrace the local ecosystem: native apps on macOS and Linux normally provide a superior experience to Windows ports. If you can't find a workable Linux equivalent to a Windows-only program, you may be able to run it using the WinApps framework (tinyurl.com/4952kw7f).

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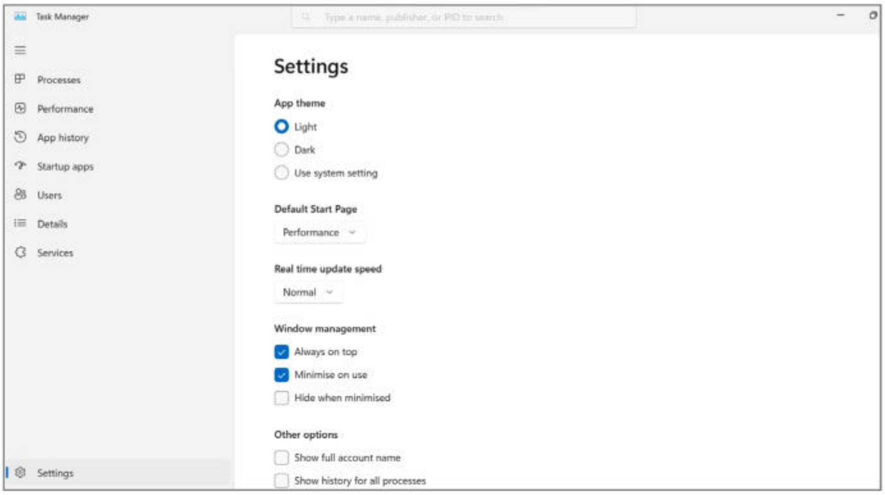
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH


Task Manager

Type a name, publisher, or PID to search

Processes
Performance
App history
Startup apps
Users
Details
Services
Settings

Settings

App theme
● Light
○ Dark
○ Use system setting

Default Start Page
Performance

Real time update speed
Normal

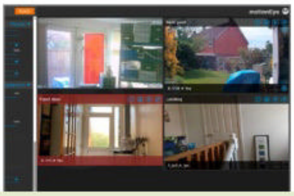
Window management
☑ Always on top
☑ Minimise on use
☐ Hide when minimised

Other options
☐ Show full account name
☐ Show history for all processes

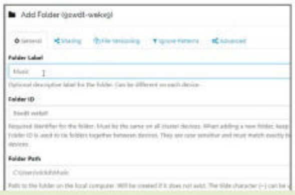
UTILIZING TASK MANAGER

If your PC is feeling sluggish or you just want to monitor its live performance, then Task Manager should be your best friend. To launch quickly, press Ctrl+Shift+Esc. Inside the app, go to options, and select 'Always on top' to ensure it overlays any open application. This means that if your game crashes, you can open this up, and end the task from here.

MAKE – USE – CREATE



62
Set up a self-hosted surveillance system



66
Keep folders in sync with Syncthing

70
The best way to fix a broken USB stick

© MICROSOFT, MOTIONEYE, SYNCTHING,

SAM LEWIS
STAFF WRITER

HANDHELD HEAVEN

With the release of the ASUS ROG Ally, the popularity of the Nintendo Switch, and handhelds coming out of every nook and cranny, it's no surprise that they've caught my interest. I come from console gaming beginnings, and have always enjoyed being able to take a slice of that kind of gaming experience on the go with a handheld device.

The Nintendo DS was the reason I first got into gaming, and while I was digging around at home, I found my old model which thankfully still had some battery life! I jumped straight on *Super Mario 64 DS*, possibly my favorite game of all time. For me, it was my first open-world title, and one of the first games that fully immersed me. That's the whole point of a good game, right?

As technology advanced and consoles got better and better, the progression between the two was always more prevalent in consoles. I had always wanted an exact console/PC experience on the go, and it's now, more than ever, a possibility. Since the Steam Deck's release, taking aspects of the Switch and combining it with some PC magic, gaming on the go is more accessible, and similar models are cropping up everywhere. This is great for us handheld lovers, and I'm certainly in the market to pick one up.

↘ submit your How To project idea to: editor@maximumpc.com

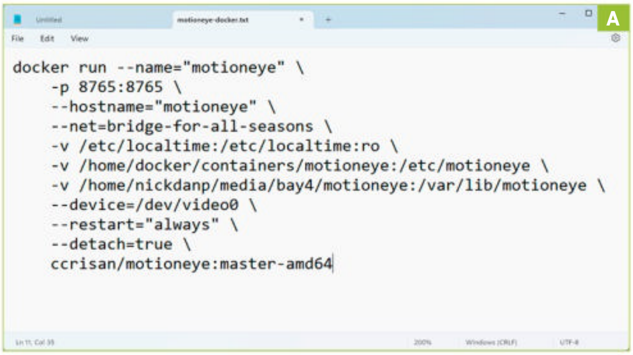
Set up a self-hosted surveillance system

YOU'LL NEED THIS

LINUX OR WINDOWS PC RUNNING DOCKER
motionEye Docker container, at least one compatible camera (USB attached or ONVIF/ RTSP-streaming IP camera).

SURVEILLANCE CAMERAS PLAY A KEY ROLE in your home's security, but many home security webcams are tied to proprietary services, with expensive cloud storage plans and question marks over the security of where that footage is stored and who can see it. Thankfully, there's a free open-source solution that puts you firmly in control of all your cameras and allows you to store your footage safely at home. The tool in question is motionEye, and it works with a wide range of cameras, from USB-attached webcams to a broad selection of network cameras that support either ONVIF or RTSP streaming protocols.

In this tutorial, we'll show you how to set up motionEye, attach as many cameras as you need to it, then configure them to provide a home surveillance system you can rely on. You'll discover how to configure motionEye's motion detection capabilities, allowing you receive alerts (and view footage) whenever activity is detected in front of a camera. You also get to choose whether to keep your new surveillance system under wraps by restricting access to your local network only, or we'll show you how to configure it in conjunction with a reverse proxy for secure remote access over the internet when you're traveling. Read on to find out how. **–NICK PEERS**



```
docker run --name="motioneye" \
    -p 8765:8765 \
    --hostname="motioneye" \
    --net=bridge-for-all-seasons \
    -v /etc/localtime:/etc/localtime:ro \
    -v /home/docker/containers/motioneye:/etc/motioneye \
    -v /home/nickdanp/media/bay4/motioneye:/var/lib/motioneye \
    --device=/dev/video0 \
    --restart="always" \
    --detach=true \
    ccrisan/motioneye:master-amd64
```

1 INSTALL MOTIONEYE

motionEye requires Linux, and you'll find detailed installation instructions for individual distros at https://github.com/motionEye-project/motionEye/wiki/Installation—however, you'll discover that it's not currently compatible with Ubuntu 22.04 or later. The simplest and most effective way to run it is through Docker, which means you can add it to your headless Ubuntu Server NAS build from September 2022, or use it in Windows through the Windows Subsystem for Linux. Another benefit of Docker is that you can integrate motionEye into your reverse proxy, making it easy (and secure) to access your video streams when away from home.

» As per our previous guidance, the simplest way to install the motionEye Docker through your server's web-based cockpit interface is to create a text file on your main PC into which you input the Docker commands shown in [**Image A**] (or simply copy, paste, and amend the Docker script shown at https://github.com/motionEye-project/motionEye/wiki/Install-In-Docker).

» You'll then need to amend the script to suit your own needs. First, you'll see motionEye communicates over port 8765—if for any reason port 8765 is being used by another service, alter the -p line accordingly (for example, '-p 8766:8765 \' to use port 8766 instead). If you plan to access motionEye remotely, you should also add the following line to join its Docker instance to the same network as your proxy server (change 'shared-network-name' to the name of your shared bridge network):

```
--net=shared-network-name \
```

» You'll also need to set up a configuration folder for your motionEye preferences, which will point to '/etc/motionEye' in the Docker script, and a folder to store video recordings, which will point to '/var/lib/motionEye'.

» If you plan to connect any locally connected webcams (ie, webcams plugged into your server via USB), then add one or more lines for each webcam like so:

```
--device=/dev/video0 \
--device=/dev/video1 \
```

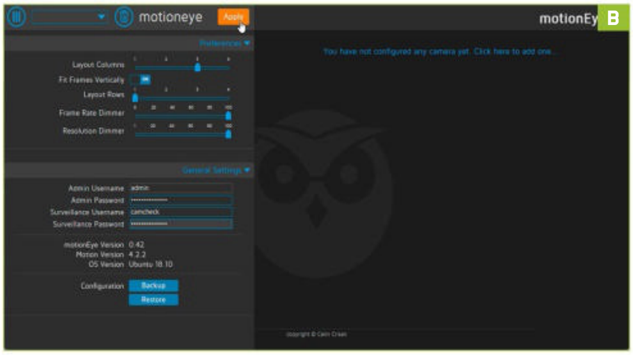
» Once the script is configured, select it all and copy it to the clipboard. Now, switch to cockpit in your browser, select Terminal from the left-hand navigation pane, and press Shift + Insert to paste the Docker script into the Terminal. Hit Enter, and all being well, motionEye should start and be available within seconds. If it doesn't, check the script carefully, then try it again.

2 INITIAL SETUP

Going forward, all interaction with motionEye will be done through any web browser on your network. Start by typing the following URL into the browser:

```
http://192.168.x.y:8765
```

» Substitute 192.168.x.y with your PC or server's IP address, and 8765 if you had to change ports earlier.

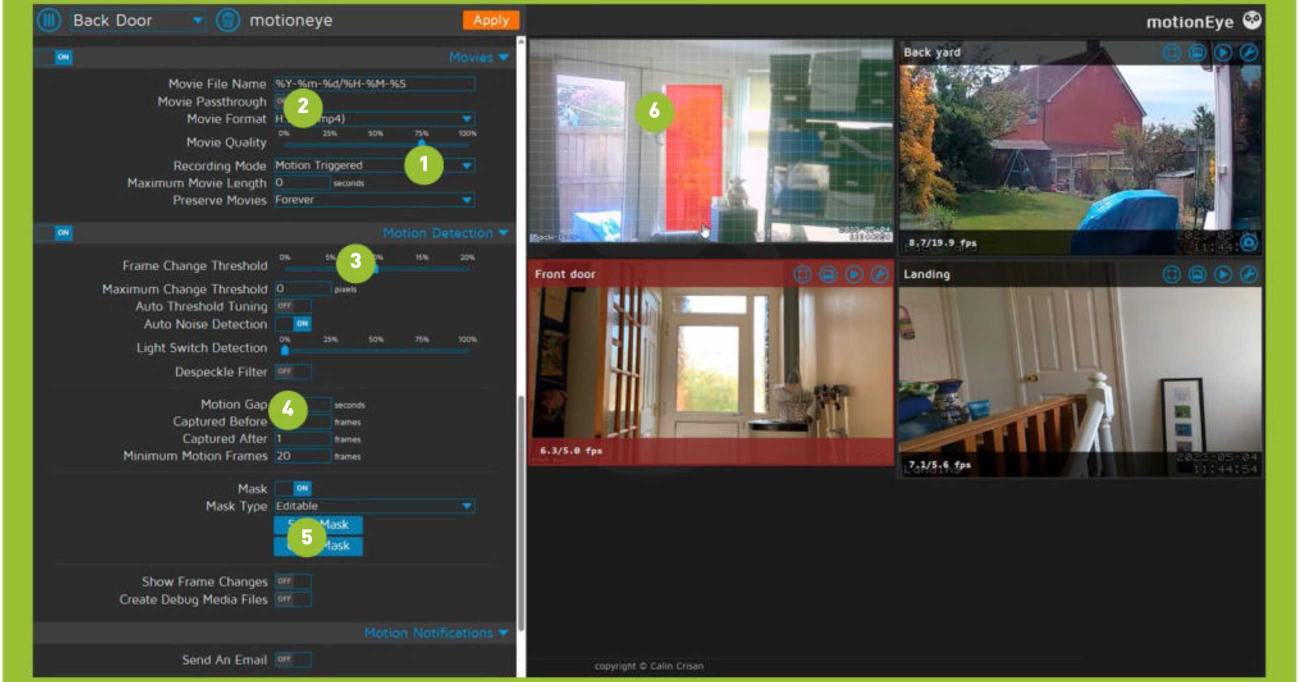


You have not configured any camera yet. Click here to add one...

Admin Username admin
Admin Password ••••••••••••••
Surveillance Username camcheck
Surveillance Password ••••••••••••••
motionEye Version 0.42
Motion Version 4.2.2
OS Version Ubuntu 18.10

© MOTIONEYE

SECURE YOUR HOME


Back Door
motioneye
Apply

Movies
ON
Movie File Name %Y-%m-%d/%H-%M-%S
Movie Passthrough
Movie Format H.264 (.mp4)
Movie Quality 75%
Recording Mode Motion Triggered
Maximum Movie Length 0 seconds
Preserve Movies Forever

Motion Detection
ON
Frame Change Threshold
Maximum Change Threshold 0 pixels
Auto Threshold Tuning OFF
Auto Noise Detection ON
Light Switch Detection 0%
Despeckle Filter OFF
Motion Gap seconds
Captured Before frames
Captured After 1 frames
Minimum Motion Frames 20 frames
Mask ON
Mask Type Editable
Show Frame Changes OFF
Create Debug Media Files OFF

Motion Notifications
Send An Email OFF

1. ENABLE MOTION DETECTION
To start recording whenever the currently selected camera detects movement, you first need to set Recording Mode to 'Motion Triggered' in the Movies section.

2. MOVIE SETTINGS
Make sure 'Movie Format' is set to a compatible format so you can review footage and download it to your PC. In most cases, the basic 'H.264 (.mp4)' option is the best one.

3. FRAME CHANGE THRESHOLD
This determines how sensitive the camera is to motion detection, with 0 the most sensitive (and so liable for more false positives). Experiment with different levels between 2 and 20 to find a happy medium.

4. MOTION GAP
The setting tells motionEye how long to wait after motion has been detected before it ends recording—the default is 30 seconds.

5. IMAGE MASK
Enable this setting for a more finely tuned approach to motion detection. This enables you to block out parts of the image where motion is ignored.

6. EDIT MASK
Set Mask Type to Editable and click 'Edit Mask' to bring up a clickable grid overlay on top of your video feed. After you've done this, click inside those squares where any movement is to be ignored.

You'll be prompted to log into the motionEye web UI. The default settings are admin (username) and no password. You'll be prompted to add your first camera, but before doing so, let's secure the web UI (doubly important if you plan to connect remotely). Click the hamburger (▯) button in the top left-hand corner to reveal the main motionEye menu panel. You'll see fields for setting both an admin user and password, and surveillance user and password. The surveillance user allows trusted people to view your webcams, but not administer the system.

» If you plan to access motionEye remotely, then for obvious security reasons we recommend changing both your username and password. Unfortunately, you can't change the admin username using the web-based UI—if you're feeling particularly security conscious, you'll need to perform some additional steps once you input the other details as shown in [**Image B**] and click Apply.

» After being logged out of motionEye, switch to cockpit's Terminal view, then navigate to the motionEye config folder you set up earlier. Here, you should find a file named motion.conf. Edit this using a text editor ('nano motion.conf') and uncomment the following line:

```
@admin_username myadminusername
```

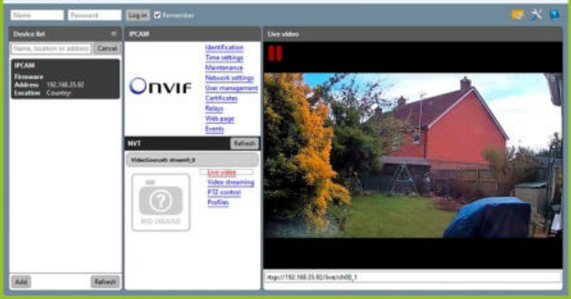
» Change 'myadminusername' to the admin username you wish to use, then save the file and restart the motionEye Docker instance ('Docker restart motionEye'). You should now be able to log in using your new hard-to-guess admin username and password.

3 ADD YOUR FIRST CAMERA

Once logged in, click 'You have not configured any camera yet. Click here to add one...' to attach your first camera to MotionEye. The Add Camera wizard should default the 'Camera Type' to 'Local V4L2 Camera', and if you've attached any cameras to your server's USB ports, they should show up here. Select the target camera from the Camera dropdown menu, and click OK.

» After a short pause, a live feed from the camera should appear on-screen. Bring up the motionEye menu again. First, use the Preferences section to configure the layout of the main motionEye screen—by default it's

CHOOSE THE RIGHT IP CAMERA



ONVIF Device Manager v2.2.250
Name
Password
Log in
Remember
Device list
Name, location or address
Cancel
IPCAM
Onvif
Identification
Time settings
Maintenance
Network settings
User management
Certificates
Relays
Web page
Events
NVT
Refresh
VideoSource0: stream0_0
Live video
Video streaming
PTZ control
Profiles
NO IMAGE
Add
Refresh
Live video

IPCAM
Firmware
Address 192.168.35.82
Location Country:

rtsp://192.168.35.82/live/ch00_1

There's no need to spend hundreds of dollars on expensive IP cameras to populate your home surveillance system, but at the same time, you can't simply purchase a cheap network camera on eBay and assume that it will automatically work with motionEye.

The most crucial thing with any IP camera is that it's RTSP or ONVIF-compliant. When searching for IP cameras, make sure they offer this before purchasing, but be aware that many cheap Chinese knock-offs advertise ONVIF/RTSP compatibility while not working out of the box. In many cases, you may need to track down a specific firmware version that unlocks ONVIF support. One camera that doesn't require a firmware update is the V380 Pro series—visit https://gist.github.com/SolveSoul and click the ceshi.ini link for instructions on how to use a simple script to unlock ONVIF capabilities and add support for motionEye.

If you're unsure or want to try and add a previously purchased IP camera to motionEye, go to www.ispyconnect.com/cameras for a list of cameras that should potentially work with motionEye. Alternatively, install ONVIF Device Manager (https://sourceforge.net/projects/onvifdm/) to see if it can detect your camera over the network and pull a video feed from it—if it can, you should be able to get it to work with motionEye using the rtsp:// protocol.

configured to show three camera feeds per row, so set Layout Columns to 2 to increase the size of each feed on-screen.

» Next, scroll down below General Settings, where you'll find a series of categories related to the configuration of this, your first video feed. Start with the Video Device section, as shown in [**Image C**] . Here, you'll see that you can alter the video resolution and frame rate from its default (a somewhat jerky two frames per second). While it's tempting to push these up to the maximum resolution and refresh rate (30fps) for a smoother experience, bear in mind the additional network bandwidth and system resources this will consume—not necessarily a problem for a single camera, but as you add more cameras to your network, you'll produce more overheads.

» The good news is that you can always change camera settings, so feel free to push these settings higher (say, 720p HD and 15fps) for now, as you can always lower them later if necessary.

» The Video Device section also allows you to rename your camera to make it more easily identifiable, and lets you alter camera settings like brightness, contrast, and hue. After making any changes, click the orange Apply button to confirm the changes and continue.

4 TWEAK MORE CAMERA SETTINGS

Beneath Video Device, you'll find eight more sections to explore. File Storage lets you alter the default storage path and see how much space is on your hard drive. Beneath this is Text Overlay, which is where you can alter the text that appears on top of your video feed: the camera name on the left, and the time stamp on the right to help identify footage going forward are the default selections, but you'll be hard-pressed to see the text on-screen at their current size. Use the Text Scale slider to make them more visible (try 3 for starters).

» Beneath this is a Video Streaming section. This allows you to set up web-based livestreams and snapshots that you can access using specific URLs, then set quality settings, choose a port to access the stream on, and add a credentials check so they're not publicly accessible. If you're content to view this camera through the main motionEye interface, flick the switch to off.

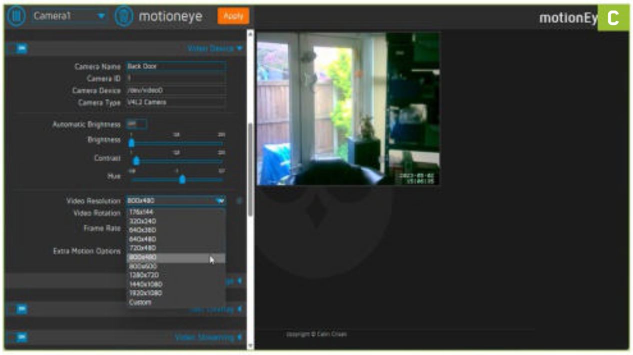
» MotionEye can also capture screenshots and record movies. Both sections allow you to choose a file-naming convention, set image or video quality, and choose how long to store these recordings for. Crucially, they give you control over when snapshots are taken. There's a manual option whereby a button is placed over the video feed for capturing on demand, but you can also take snapshots at set intervals every few frames, and—for security purposes—when the camera detects motion.

5 CONFIGURE MOTION DETECTION

Motion Detection is handled in its own section where you have full control over sensitivity settings. Roll the mouse over each option to reveal a '?' button on the right. Hover the mouse over this, and an explanation of how that setting works is revealed. For a brief guide to getting this set up and seeing what control does what, check out the annotation.

» If you want an alert whenever motionEye detects movement and records, expand the Motion Notifications section. Most people will want to receive an email alert with an optional image snapshot—just fill in the address you wish to send your alerts too, and provide details about the account you wish to send mail from. Other options—call a web hook, run a command, and run an end command—are for more tech-proficient users.

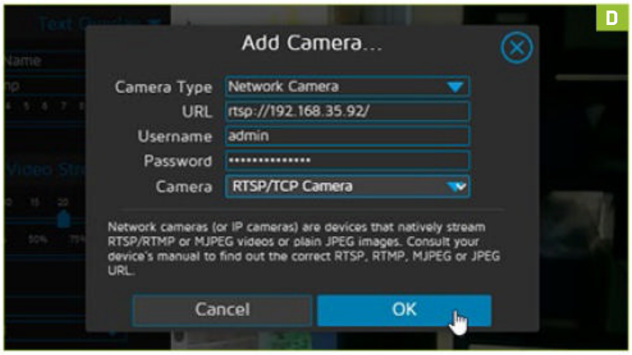
» The final section—Working Schedule—allows you to limit motionEye's motion detection tools to specific times of day, so you're not subject to a barrage of false-positive alerts when people are in the vicinity. You can set specific hours and days, but remember to flick Working Schedule to Off when you're away for longer periods so motionEye can keep an eye out until your return.



Camera1
motioneye
Apply
Video Device
Automatic Brightness
Brightness
Contrast
Hue
Video Rotation
Frame Rate
Extra Motion Options
176x144
320x240
640x360
640x480
720x480
800x480
800x600
1280x720
1440x1080
1920x1080
Custom
Video Streaming
motionEy
C

Camera Name Back Door
Camera ID 1
Camera Device /dev/video0
Camera Type V4L2 Camera
Video Resolution 800x480

© MOTIONEYE


D

Add Camera...

Camera Type: Network Camera
URL: rtsp://192.168.35.92/
Username: admin
Password: ••••••••••••••
Camera: RTSP/TCP Camera

Network cameras (or IP cameras) are devices that natively stream RTSP/RTMP or MJPEG videos or plain JPEG images. Consult your device's manual to find out the correct RTSP, RTMP, MJPEG or JPEG URL.

6 ADD ADDITIONAL CAMERAS

To add a second (and subsequent) camera to your surveillance network, click the dropdown arrow next to your current camera's name, then select 'add camera…' from the menu. Adding further USB cameras is simple enough, but in most cases you'll be looking to add network cameras positioned elsewhere in and around your home, including outside.

» You'll need an IP camera that either meets RTSP or ONVIF standards, or which transmits an MJPEG video stream over the network. See the box for advice on sourcing one or checking to see if your cheap Wi-Fi camera can be converted to work with motionEye. Select 'Network Camera' from the dropdown menu, and then fill in the required details as shown in [**Image D**]: the URL, plus any username or password required to access its feed. If you didn't set up user credentials when configuring the camera initially, you should log into the camera using the default settings (see the user manual or website), then set up a secure username and password before adding the camera to motionEye.

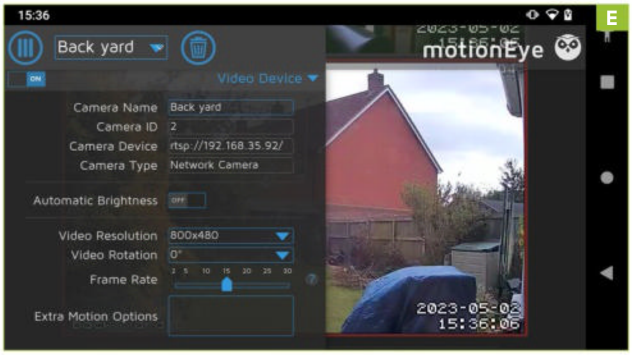
» If MotionEye is able to connect successfully, the Camera field will be filled with the camera model and you'll be able to click OK; if not, check the manual or web for instructions. If successful, after a short pause, the camera's feed will appear in the main motionEye window, ready for you to configure in the same way you set up your first camera.

7 SET UP REMOTE ACCESS

If you'd like to keep an eye on your home, you'll need to pair motionEye with a suitable domain and reverse proxy. This is relatively straightforward if you're using the web-based Nginx Proxy Manager, which we featured in our self-hosted password manager tutorial in the April 2023 issue. Once you've set up your dynamic domain or subdomain, log into Nginx's browser-based interface and select Proxy Hosts followed by 'Add Proxy Host'.

» Enter your domain or subdomain name into the Domain Names field and click Add, leave http selected under scheme, and enter your server's IP address into the Forward Hostname/IP field. Enter port 8765 (or the port you configured in step 1) into the Forward Port box, and switch to the SSL tab. Click on None and select 'Request a new SSL Certificate (with LetsEncrypt)', flick the Force SSL switch on, enter your email, agree to the LetsEncrypt terms, and click Save.

» When the redirect is set up, open a new browser tab and attempt to connect directly to the subdomain or domain you just configured. If all is well, you should find yourself at the motionEye login screen.


E

15:36

Back yard

ON

Video Device

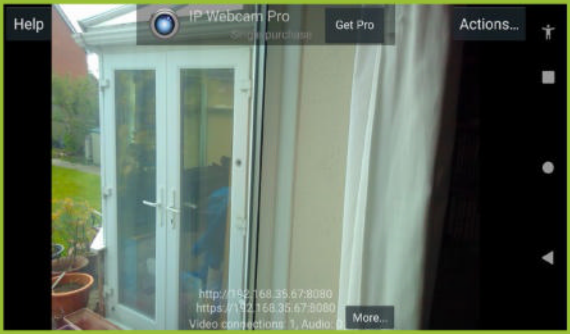
Camera Name: Back yard
Camera ID: 2
Camera Device: rtsp://192.168.35.92/
Camera Type: Network Camera
Automatic Brightness: OFF
Video Resolution: 800x480
Video Rotation: 0°
Frame Rate: 15
Extra Motion Options

8 MONITOR YOUR HOME

The obvious way to get an overview of your home is to log into the web address you configured in the previous step. Android users can also use the app from FutureJJ, which allows you to view and manage your camera feeds via a familiar-looking—but mobile-optimized—interface, as shown in [**Image E**]. It can even be used across multiple motionEye servers.

» Once logged into the front end, click on a camera feed to reveal various buttons, most of which are self-explanatory. They include picture and movie browsers where any stored snapshots or recordings for the selected camera can be viewed and downloaded (or deleted to free up space).

REUSE OLD PHONES


Help
IP Webcam Pro
Get Pro
Actions...
http://192.168.35.67:8080
https://192.168.35.67:8080
Video connections: 1. Audio: 0
More...

Following our advice in the April 2023 issue, a great use for old, obsolete phones is as an IP web camera. You'll need a specialist app to create the necessary stream that will work with motionEye—we recommend Pavel Khlebovich's IP Webcam (free) for Android, and ipCam ($2.99, https://skjm.com/ipcam/) for iPad and iPhone.

Configuration is relatively simple. Simply enable ONVIF support in IP Webcam and then start the server—the URL you'll need when connecting your phone as a Network Camera is `rtsp://192.168.x.y:8080/h264_ulaw.sdp`—we recommend taking the time to add username and password protection to the feed in the app's settings.

With ipCam, the URL you need when setting up the camera as a Network Camera is http://192.168.x.y/video.mjpg—again, use the app's options to configure password protection for additional security.

Once configured, all you need to do is find a suitable location for your phone, one that's close to a power socket to ensure your mobile doesn't die at a crucial moment, plus a stand to place it on. You'll find numerous options available on Amazon and eBay, but if your budget's tight, you could fashion a simple stand out of everyday objects such as a paperclip or expired credit card as shown on Wikihow (https://www.wikihow.com/Make-a-Phone-Stand).

Keep folders in sync with Syncthing

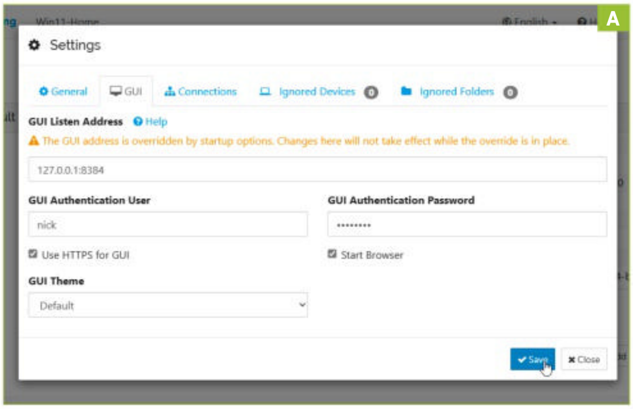
YOU'LL NEED THIS

SYNCTHING (https://syncthing.net) plus at least two networked devices running one of Windows, macOS, Linux, Android, or NAS (Synology or QNAP)

WANT TO KEEP TWO OR MORE FOLDERS in sync across multiple devices? Looking for a quick and easy way to set up a shared folder without having to worry about networking protocols (never mind file and folder permissions)? Interested in a file-sharing solution that works over the internet with friends and family? Or how about setting up a secure backup, one that can be encrypted before it's transferred so your data is untouchable on any device you back up to?

Syncthing covers all these bases. It's a continuous file synchronization app, which means you simply copy a file into a monitored folder, then Syncthing will automatically (and securely) transfer it to any devices you've linked to that specific folder. Any subsequent changes, such as editing, moving, or even deleting a file, will be replicated across all synced devices to keep the folders perfectly in sync.

In this tutorial, we'll cover everything you need to know, from installing the program and introducing devices to each other to configuring shared folders and resolving potential file conflicts. The good news is that it's all completely secure—thanks to TLS encryption and perfect forward secrecy, your data is safe from hackers or man-in-the-middle attacks. **–NICK PEERS**



GUI Listen Address

The GUI address is overridden by startup options. Changes here will not take effect while the override is in place.

127.0.0.1:8384

GUI Authentication User: nick

GUI Authentication Password: •••••••••

☑ Use HTTPS for GUI

☑ Start Browser

GUI Theme: Default

1 INSTALLING SYNCTHING

You'll need to source Syncthing for each device you plan to install it on. A comprehensive list of downloads for Windows, macOS, Linux, and Android can be found at https://syncthing.net/downloads/—plus you can use it to keep folders on your Synology or QNAP NAS in sync, too—you'll find Syncthing in Synology's official Package Center, while QNAP users will need to first add the qnapclub.eu repo (see https://qnapclub.eu/en/howto/1 for instructions), then install Syncthing through that.

» Windows users will be redirected to https://github.com/canton7/SyncTrayzor to download SyncTrayzor, a simple wrapper for Syncthing. SyncTrayzor not only handles the installation (and updating) of Syncthing itself, but provides you with a dedicated tool that runs from the Taskbar's notification area, as well as access to Syncthing's web-based interface through its own program window.

» If you're running Ubuntu, head over to https://apt.syncthing.net/ and copy and paste the commands into a Terminal window. This will install the daemon and command-line tool to allow you to administer Syncthing through a web browser. If you're running a desktop version of Ubuntu, you can also install Syncthing-GTK, which works in a similar way to SyncTrayzor. Once Syncthing is installed, issue the following command in the Terminal:

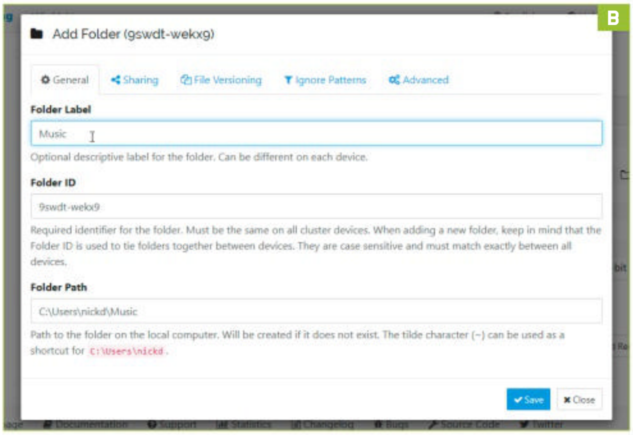
```
sudo apt install syncthing-gtk
```

2 FIRST-RUN SETUP

Either launch SyncTrayzor or Syncthing-GTK, or enter http://localhost:8384 into your web browser to access Syncthing's GUI. If using SyncTrayzor, you may be prompted to give it access through the Windows Firewall (do so). You'll also notice that SyncTrayzor opens with a two-paned view—you can hide the potentially distracting console pane from view by unchecking 'Syncthing Console' on the View menu.

» When the web interface pops up, click Yes or No to allow anonymous reporting. You'll then be prompted to set up a user account name and password to secure the web interface. This only applies when accessing Syncthing through your web browser, so if using Synctrayzor or Syncthing-GTK, click OK, and skip to the next step.

» If you're connecting through a web browser, we recommend clicking Settings to access Syncthing's general preferences dialog. Switch to the GUI tab, where you'll find fields for entering a username and password. For additional security, check 'Use HTTPS for GUI' before clicking Save as shown in [**Image A**]. You'll be



Folder Label: Music

Optional descriptive label for the folder. Can be different on each device.

Folder ID: 9swdt-wekx9

Required identifier for the folder. Must be the same on all cluster devices. When adding a new folder, keep in mind that the Folder ID is used to tie folders together between devices. They are case sensitive and must match exactly between all devices.

Folder Path: C:\Users\nickd\Music

Path to the folder on the local computer. Will be created if it does not exist. The tilde character (~) can be used as a shortcut for `C:\Users\nickd`.

© SYNCTHING

logged out, so go to https://localhost:8384, where you'll see a security warning about an invalid security certificate. This can be bypassed—in Firefox, for example, click Advanced... followed by 'Accept the Risk'—then enter your user credentials to return to the main Syncthing interface.

» If you'd like to administer Syncthing from another device on your network, check the box for details.

3

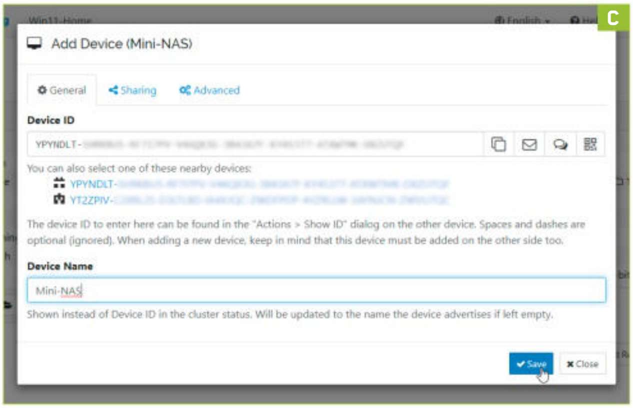
SELECT YOUR FIRST FOLDER

Syncthing starts with a single folder set up to sync, which it names Default Folder. Click this to reveal more details, including its location (C:\Users\{username}\Sync), along with its global and local state, which—as it's currently empty—is displayed as 0 files, 0 folders, 0 bytes. You're at liberty to use this folder if you wish, but it's more likely you have a folder populated with the content you wish to back up or sync, in which case click Edit underneath Default Folder, followed by Remove and Yes to delete it.

» Next, click the 'Add Folder' button. You'll see the folder ID and Folder Path are prefilled. Clear the Folder Path and—if using SyncTrayor—type the full path to the folder you wish to synchronize. If using the web interface, however, then Syncthing provides a handy autocomplete prompt. Start typing the drive letter (such as C:\) in Windows or / on a Linux-based system, and a dropdown menu pops up listing all the folders at that level. Select a folder, and another pop-up menu will appear listing all the highlighted folder's subfolders. Keep choosing folders until you've input the path to your target folder. Next, enter a suitable Folder Label to help identify the folder you've selected, as shown in [**Image B**].

» There are four further tabs to explore before applying your changes with the Save button. Ignore the Sharing tab for now and switch to the File Versioning tab. If you want to use Syncthing as a backup tool, you should examine one of the available options: Trash Can File Versioning simply prevents files being accidentally wiped by holding them in a trash can for a user-defined number of days before deleting them forever. Simple File Versioning and Staggered File Versioning let you store multiple versions of a file—either a set number of copies (simple) or multiple copies over set intervals for a specific period (staggered). Select one for a full description and to see what options it supports.

» Use the Ignore Patterns tab if there are files or folders you wish to exclude from your sync for any reason, then finish on the Advanced tab, where you'll find numerous additional options. Of possible interest is the Folder Type dropdown, which allows you to switch from a two-way sync to sending files in one direction only.


C

Add Device (Mini-NAS)

Device ID

YPYNDLT-[redacted]

You can also select one of these nearby devices:
- YPYNDLT-[redacted]
- YT2ZPIV-[redacted]

The device ID to enter here can be found in the "Actions > Show ID" dialog on the other device. Spaces and dashes are optional (ignored). When adding a new device, keep in mind that this device must be added on the other side too.

Device Name

Mini-NAS

Shown instead of Device ID in the cluster status. Will be updated to the name the device advertises if left empty.

4

CONNECT DEVICES

Syncthing will now scan the folder, which you'll see is marked as 'Unshared', so the next thing to do is set up Syncthing on the computer or NAS drive you wish to sync the files to. Repeat steps one and two on this secondary device, then create a folder on there to store the files you're about to sync.

» The next step is to 'introduce' your PC to your new device. From your PC, click 'Add Remote Device' under Remote Devices. You'll be prompted to enter the Device ID of the device you wish to connect to. Syncthing automatically detects 'nearby devices' (any device on your network that is running Syncthing) and lists them. Click one, and it will pre-fill its code in the Device ID field.

» The Device ID isn't particularly helpful in identifying which device is which, so be sure to enter a more descriptive label in the Device Name field, before clicking Save, as shown in [**Image C**].

» Going forward, if you set up more Syncthing instances on your network, or wish to connect to a device outside your local network (say, a friend or family member), you'll need to know the Device ID you plan to connect to. This can be found on the target device under Actions > Show ID, where you'll also see options to copy the ID string, share it by email or SMS, or scan a QR code.

» The device will now appear under Remote Devices listed as 'Disconnected (Unused)', indicating that the connection isn't yet confirmed. You need to switch to the secondary device where you'll see Syncthing displays a prompt asking you to confirm the connection: click Add Device to do so, and after a short pause, it'll change to 'Connected (Unused)'.

ACCESS SYNCTHING REMOTELY

By default, Syncthing can only be configured on the machine it's installed on, but it's possible to set it up so you can access it on any web browser on your local network. To configure this in SyncTrayzor, click File > Settings and switch to the Syncthing tab; in the web interface, select Actions > Settings > GUI tab instead.

You'll see the current GUI Listen address is 127.0.0.1:8384. Change this to 0.0.0.0:8384 and click Save. Now, open a web browser on another machine and enter https://192.168.x.y:8384 (where 192.168.x.y is the IP address of your Syncthing instance) to connect and configure Syncthing remotely.

If you've set up Syncthing on a headless server like our NAS build from September 2022, you'll need to edit a configuration file to allow you to gain access. Log into your NAS build using Cockpit in your browser, then select Services. Locate Syncthing's entry and temporarily stop it. Now, switch to Terminal and enter the following command:

```
nano .config/syncthing/config.xml
```

Locate the following lines:

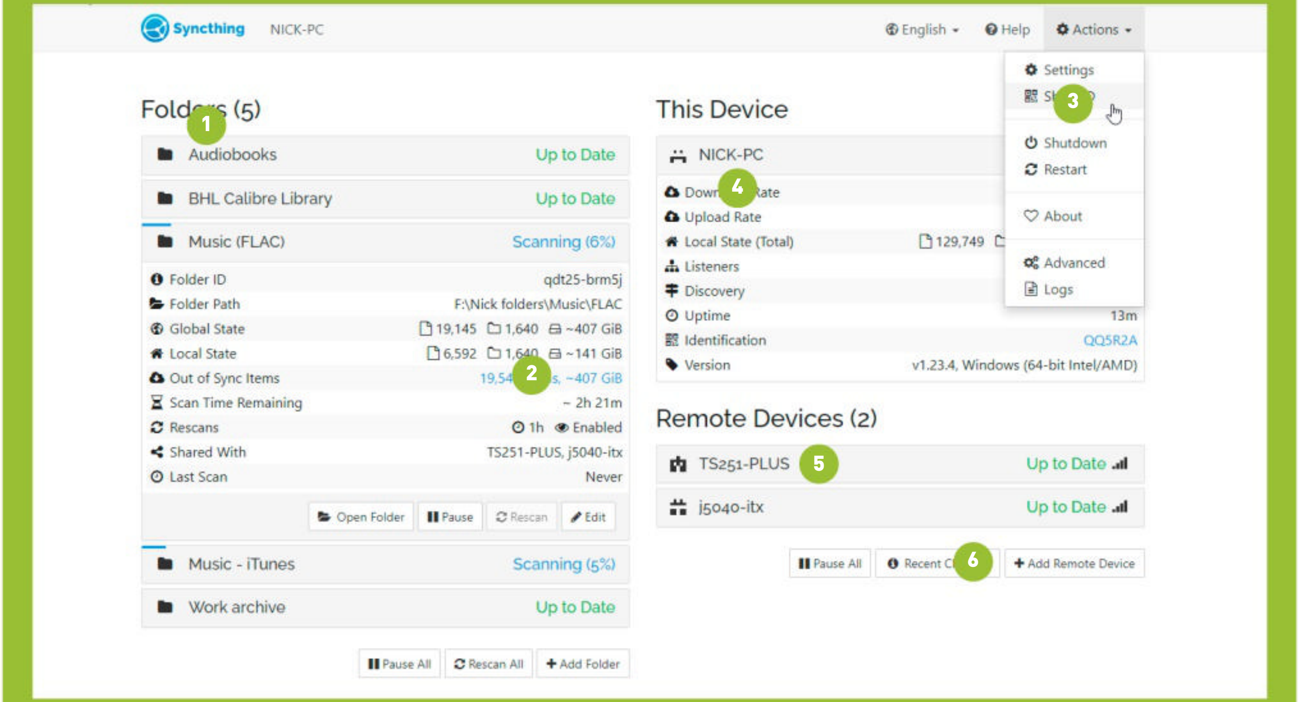
```
<gui enabled="true" tls="false">
  <address>127.0.0.1:8384</address>
```

Change this second line so it reads:

```
  <address>0.0.0.0:8384</address>
```

Press Ctrl + X, type `Y` and Enter to make the change, then restart Syncthing via the Services tab of Cockpit.

MONITOR YOUR SYNCED FOLDERS



Folder ID qdt25-brm5j
Folder Path F:\Nick folders\Music\FLAC
Global State 19,145 1,640 ~407 GiB
Local State 6,592 1,640 ~141 GiB
Out of Sync Items 19,54 s, ~407 GiB
Scan Time Remaining ~ 2h 21m
Rescans 1h Enabled
Shared With TS251-PLUS, j5040-itx
Last Scan Never

Down Rate
Upload Rate
Local State (Total) 129,749
Listeners
Discovery
Uptime 13m
Identification QQ5R2A
Version v1.23.4, Windows (64-bit Intel/AMD)

1. FOLDER LIST
A summary of the folders you've set up for sharing is shown here, including file-syncing progress. Click one to expand it and reveal more details about it.

2. VIEW FILE TRANSFERS
Click 'Xxxxx items, ~Xx GiB' item to bring up a progress window for that shared folder. This will show which files are transferring, as well as those that have been transferred, and those waiting to be copied across.

3. ACTIONS MENU
Click here to access Syncthing's universal settings. You can also view your device ID, shut down or restart the underlying Syncthing process, view the logs, and access an advanced menu offering yet more options.

4. DEVICE PROPERTIES
Get an overview of your device's current state, including how much data has been uploaded and downloaded since you last started Syncthing.

5. REMOTE DEVICES
This is a list of all the devices you've connected to. Click one to view a summary of its status, plus reconfigure your connection to it (click Edit).

6. RECENT CHANGES
Click this button to see which files have most recently been uploaded or downloaded. Click 'Pause All' to temporary stop transferring data, and 'Add Remote Device' to connect to another instance of Syncthing.

5 SET UP FOLDER PAIR

Once devices are connected, there are two ways to share folders between them. The first is to click Edit under one of the directories listed under Folders, then switch to the Sharing tab to view a list of connected devices. Alternatively, expand the device's entry under Remote Devices and click Edit > Sharing tab, where you'll see a list of folders.

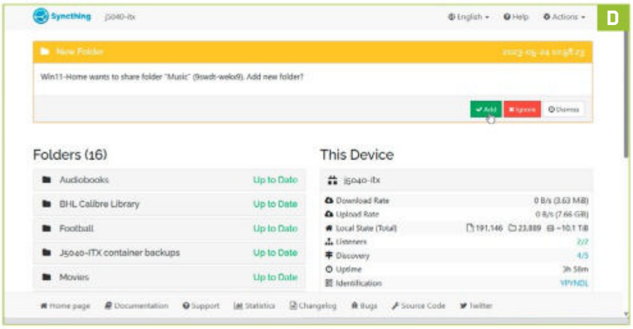
» In both cases, you need to check the relevant device or folder you wish to share. In both cases you'll see an option to make the connection untrusted by entering an encryption password (the usual rules about choosing a strong 14-character password apply). This creates a 'Receive Encrypted' folder-type connection, meaning a one-way connection from your PC to the target device is established. While the files remain accessible on your PC, the copies sent to the target are left encrypted, so they're inaccessible on that device. See https://docs.syncthing.net/users/untrusted.html for information on how this works.

» You'd only want this option when backing up files to a remote location, so in most cases you can ignore it and simply click Save before switching to the secondary device. Here, you'll see a confirmatory prompt appear, as shown in [**Image D**]. Click Add, and the Edit Folder dialog will open. The crucial setting here is 'Folder Path', which you need to point to where the files will be stored on your secondary device. You can also set the folder label to a more descriptive term—it doesn't need to match the label on the original device. Once the folder is set up on your target device, click Save.

6 THE SYNC PROCESS

Syncthing will now start comparing the contents of each directory. If you've chosen a two-way sync, then if your target device's folder already contains files, they will be compared with those on your original device and copied across if they don't exist, or are considered newer than any matching files already present.

» The time it takes to compare and sync folders depends on the size of the original folder, the number of files that require syncing, and—of course—your network connection. Even over local networks it can take hours, if



Win11-Home wants to share folder "Music" (9owdt-welo9). Add new folder?

Folders (16)

Audiobooks	Up to Date
BHL Calibre Library	Up to Date
Football	Up to Date
J5040-ITX container backups	Up to Date
Movies	Up to Date

This Device

j5040-itx

Download Rate	0 B/s (3.63 MiB)
Upload Rate	0 B/s (7.66 GiB)
Local State (Total)	191,146 23,889 ~10.1 TiB
Listeners	2/2
Discovery	4/5
Uptime	3h 58m
Identification	VPYNDIL

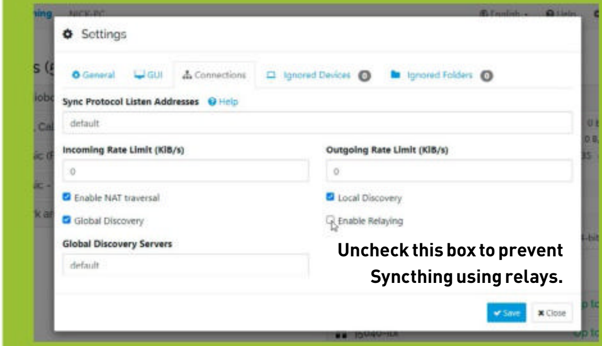
not days, to fully sync up huge folders. Thankfully, the Syncthing web interface—as shown in the annotation—makes it easy to track the progress of individual folders.

» Data can only be transferred between devices that are connected to each other—when a connection request is approved, each device is identified using its own cryptographic certificate, which is used in conjunction with TLS to encrypt all communications—including the transferring of files and folders. This results in "perfect forward secrecy", which means no man-in-the-middle attack or hacker can gain access to your data.

» Where possible, Syncthing employs direct peer-to-peer connections. This means devices connect directly to each other to avoid intermediaries like cloud storage—this is always the case when transferring to other devices on your local network, and usually applies to remote connections, too. However, there may be times when a direct connection isn't possible, at which point Syncthing makes use of public relays to bounce data between the two devices. These relays know your IP address and device ID, but the traffic remains encrypted.

» Because transferring data through a relay is slower than a direct connection, Syncthing will periodically look to see if a direct connection can be re-established. If you're uncomfortable with exposing your IP address and device ID to a public relay (your data remains untouchable), check out the box for some tips to ensure only direct connections are used.

ELIMINATE THE USE OF RELAYS



Sync Protocol Listen Addresses: default

Incoming Rate Limit (KiB/s): 0

Outgoing Rate Limit (KiB/s): 0

☑ Enable NAT traversal

☑ Local Discovery

☑ Global Discovery

☐ Enable Relaying

Global Discovery Servers: default

Uncheck this box to prevent Syncthing using relays.

If you're uncomfortable with using relays to sync data over the internet, there are several ways you can avoid using them. First, check your router's port forwarding settings at both ends of any remote connection. If UPnP is enabled, the ports should already be opened. If this isn't the case, go into your router's setup utility, and create rules to forward port 22000 on both TCP and UDP to the IP address of any one device running Syncthing on your local network. We recommend choosing one that's on 24-7 (such as your NAS or server), as all the other devices on your network will connect through that if necessary to avoid the use of a relay.

You may also need to check that your PC's firewall is configured to allow traffic from port 22000 (again TCP and UDP) as well as port 21027 (UDP). Linux users with ufw (Uncomplicated Firewall) installed simply need to enter the following command to give Syncthing the access it needs:

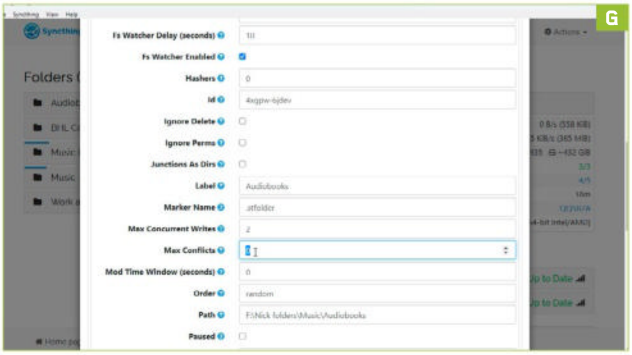
```
sudo ufw allow syncthing
```

Finally, you can ban Syncthing from using relays by navigating to Actions > Settings > Access tab on each device, and unchecking 'Enable Relaying'.

7 RESOLVING FILE CONFLICTS

File conflicts occur when Syncthing detects two different versions of the same file, but can't decide which is the correct version—usually when the same file is changed simultaneously on multiple devices. When this happens, it adopts a 'smart file conflict system', which means it defers the decision to you. The newer version of the file is left untouched (filename.<ext>), while the older version is renamed filename-synct-conflict-<date>-<time>-<device-modifier>.<ext>.

» By default, up to ten versions of a conflicting file can exist at once. The good news is that Syncthing's web interface will flag up file conflicts, but resolving them requires you to manually go into the folder on one of the linked devices to review each file using a tool like KDiff3 from https://download.kde.org/stable/kdiff3/ to highlight the differences. When you've determined which version you want to keep, you need to delete all other copies and—if necessary—rename the retained file to just filename.<ext> to resolve the conflict.



Fs Watcher Delay (seconds)	10
Fs Watcher Enabled	☑
Hashers	0
Id	4xgpw-6jdev
Ignore Delete	☐
Ignore Perms	☐
Junctions As Dirs	☐
Label	Audiobooks
Marker Name	.stfolder
Max Concurrent Writes	2
Max Conflicts	
Mod Time Window (seconds)	0
Order	random
Path	F:\Nick folders\Music\Audiobooks
Paused	☐

© SYNCTHING

» SyncTrayzor users are better served—it has a dedicated built-in conflict resolver. To access this, select File > Conflict Resolver. After a short scan, a list of conflicted files will show. Select one, and you'll see the original, plus conflicting versions. Review the files (don't always assume the one with the latest time stamp is the newest version) before clicking Choose next to the version you want to keep—SyncTrayzor will do the rest.

» The number of conflicting files is configured on a per-folder, per-device basis, so if you want to reduce this number or disable the feature altogether (and live with the consequences of the wrong version of a file being retained), you'll need to repeat the following process on all devices connected to the folder in question.

» First, open Actions > Advanced, then expand the Folders section, followed by the folder you wish to change. Scroll to the 'Max Conflicts' section and change it to the number of conflicts you will tolerate, or set it to 0 to disable it, as shown in [**Image E**]. Finally, click Save.

Fix a Broken USB Stick

YOU'LL NEED THIS

A BROKEN OR PROBLEMATIC USB THUMB DRIVE
If it's not working then it's ideal.

MOST OF US HAVE A PLETHORA OF USB STICKS lying around that most of the time either stay empty or are only brought out for infrequent tasks like reinstalling Windows. But what if you've got some important files on one, such as photos or documents, and no matter what you do, you can't get it to work? Well, if you have a USB stick that's bent or won't connect, follow these instructions to fix it and recover your data. –**NIK RAWLINSON**

1 DIAGNOSE THE DAMAGE

First, thoroughly examine your USB stick. If the plug is misshapen, be very wary of connecting it to your computer: if it gets stuck, you could seriously damage your PC's USB port, and may need to pay someone to fix it.

» If it's a USB-A device, and only the rectangular metal sleeve that surrounds the contacts is bent, try bending it back into shape using long-nosed pliers (but avoid touching the contacts themselves so as not to scratch them).

» The metal sleeve at the end serves two purposes: it protects the contacts and helps keep the USB stick in position when connected—but doesn't play a role in transferring data. Therefore, even if the sleeve is entirely removed [**Image A**], your USB stick should still work.

» If the stick's case is damaged elsewhere, be careful not to touch any internal components. This will help avoid both the risk of short-circuiting the device, and of giving it a bolt of static electricity from your fingers.

» Turn on your PC speakers, make sure you're logged into Windows, and plug in the stick. Windows will make a sound if it connects, and you can double-check that it's been recognized by opening a File Explorer window and looking for the stick's drive letter in the left-hand sidebar.

» If you can't see it, make sure the section for your computer and its drives is expanded (it will have a down-pointing arrow beside it, and the list of drives will appear below).

» If the USB stick doesn't connect, try using a different USB port and—if possible—a different computer, to make sure the problem isn't with the port itself.

» Still no luck? Use Windows Update to check for any new or updated drivers for your system, which may control access to and data flow across the USB ports. If your stick now connects, but you still can't access your data, skip to Step 3. Otherwise, continue with Step 2.

2 REPAIR ANY PHYSICAL DAMAGE

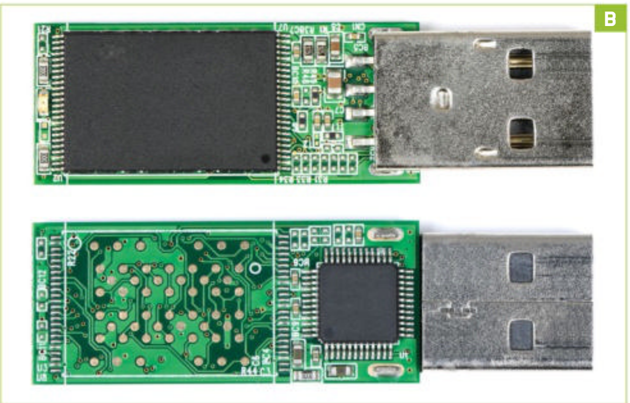
If Windows can't connect to your stick and it shows no obvious signs of damage, remove it from the socket, and first examine the contacts. As the exposed part of the device, they are the most likely area to sustain damage. If they are loose and it's obvious where they were previously attached, you could try soldering them back into position. This will probably be practical only if your stick has a rectangular Type A connection, not the smaller and reversible USB-C.

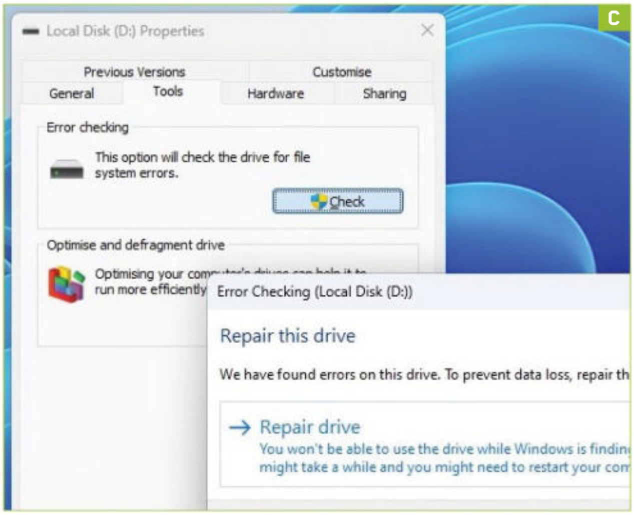
» However, soldering is risky because it involves working with extremely high temperatures. Soldering irons [**Image B**] often have temperature controls for use with different types of solder, and you'll probably need to turn them to around 2,200 Celsius (4,300 Fahrenheit) to first remove any old solder before applying its replacement.

» Removing old solder can be fiddly, but it's easier if you have a solder sucker (also called a desoldering pump) to hand. This uses a spring to release and quickly pull back a plunger, which briefly creates a vacuum that sucks the molten solder from your device. Amazon's best-selling soldering kit is this $17 set: amazon.com/Soldering-Interchangeable-Adjustable-Temperature-Enthusiast/dp/B087767KNW/. It contains everything you need for DIY fixes.

» When applying new solder, use the smallest amount you can, and be careful not to solder across more than one contact at a time. Doing so risks short-circuiting your stick.

» If the problem is a bent motherboard, be very careful if you decide to try and bend it back into position.




C
Local Disk (D:) Properties
Previous Versions
Customise
General
Tools
Hardware
Sharing
Error checking
Check
Optimise and defragment drive
Error Checking (Local Disk (D:))
Repair this drive
Repair drive

This option will check the drive for file system errors.

Optimising your computer's drives can help it to run more efficiently

We have found errors on this drive. To prevent data loss, repair th

You won't be able to use the drive while Windows is findin might take a while and you might need to restart your com

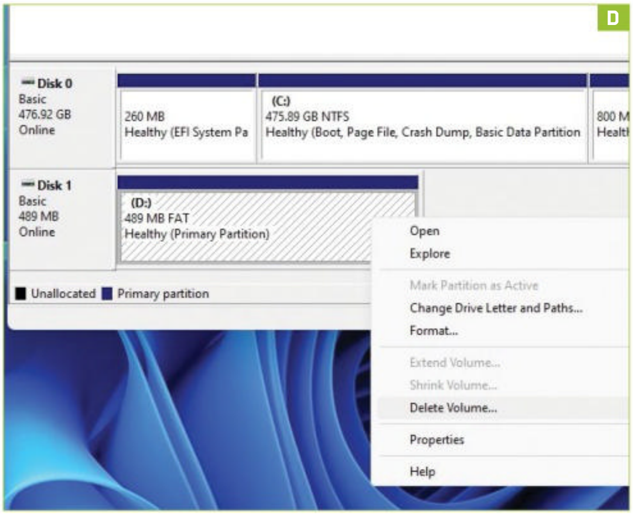
If you snap it by being hasty or heavy handed, you'll cause more problems than you solve.

» Unfortunately, if the problem is within the USB stick's enclosure, your chances of performing a physical repair are slimmer, even if you can gain access. The contacts within the body are much smaller than those in the plug, which makes it impractical to solder them yourself. It may not be possible to reattach a loose chip to the motherboard either, in which case the likelihood of recovering your data is close to nil.

3 CHECK IF THE STICK IS CORRUPTED

Right-click the stick in the File Explorer sidebar and click Properties. Switch to the Tools tab [**Image C**], then click the Check button in the 'Error checking' box. This will check the stick for system errors and, if it can, give you the opportunity to repair them.

» If this doesn't help, try using third-party data-recovery tools, as we explain in the boxout.


D
Disk 0
Basic
476.92 GB
Online
260 MB
Healthy (EFI System Pa
(C:)
475.89 GB NTFS
Healthy (Boot, Page File, Crash Dump, Basic Data Partition
800 M
Healtl
Disk 1
Basic
489 MB
Online
(D:)
489 MB FAT
Healthy (Primary Partition)
Unallocated
Primary partition
Open
Explore
Mark Partition as Active
Change Drive Letter and Paths...
Format...
Extend Volume...
Shrink Volume...
Delete Volume...
Properties
Help

4 IF ALL ELSE FAILS...

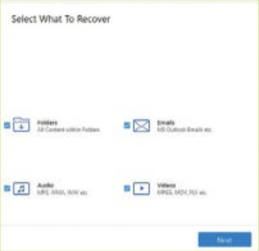
If nothing has worked, try cutting your losses and repartitioning the stick. This reduces the chance of rescuing your data, so only try this if you have a backup or are prepared to sacrifice what's on the stick. If nothing else, it might mean you can use the stick to its full capacity again.

» To do this, plug in the stick, then press the Windows key, type partition and click 'Create and format hard disk partitions'. Identify your USB stick in the list of drives by matching its capacity in the first column [**Image D**], then right-click any existing partition, and click 'Delete Volume...'.

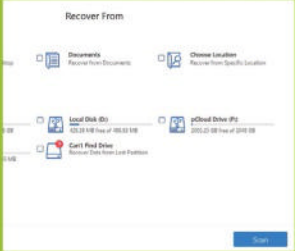
» Click 'Yes' to confirm deletion, then right-click again and this time click 'New Simple Volume...'. Follow the instructions, accepting the default options, to format the stick. If this has fixed your problem, it should open in File Explorer as a new blank drive. ⏻

RECOVER YOUR DATA

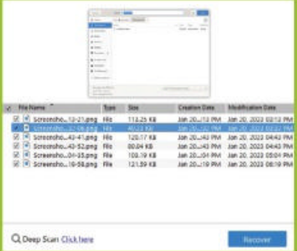
There are plenty of data-recovery tools, but as there's no guarantee you'll be able to recover any data, it makes sense to start with Stellar Data Recovery (stellarinfo.com). It will scan your device and recover up to 1GB at no cost. If more than 1GB can be recovered, you can upgrade to the Standard edition at $60 a year. Here are our Workshop instructions...


Select What To Recover
Next

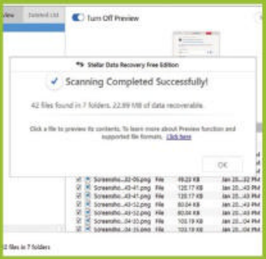
1. Launch the program and, on the first page, untick any file types that you don't want to search for. If you only want to recover lost images, for example, untick everything other than Photos. Click Next.


Recover From
Documents
Choose Location
Local Disk (D:)
pCloud Drive (P:)
Can't Find Drive
Scan

2. Click the drive letter assigned to your corrupted USB stick. Note that you can also use Stellar Data Recovery to scan a hard drive—either internal or external—if that's where you last saw your lost data. Click Scan.


File Name
Type
Size
Creation Date
Modification Date
Deep Scan Click here
Recover

3. The software will now search your USB stick for corrupt or deleted files and list what it finds. Click each result to see a preview in the top pane, and click Recover when you find one you want to restore.


Turn Off Preview
Stellar Data Recovery Free Edition
OK

Scanning Completed Successfully!

4. If it doesn't find what you're looking for, click 'Click here' beside Deep Scan at the bottom of the window, and it will perform a more thorough search. In our test, this increased the number of found files from six to 42.

© STELLAR DATA RECOVERY, GETTY IMAGES, MICROSOFT

LAB NOTES

GUY COCKER, EDITOR-IN-CHIEF

Modular Mayhem

PC building is about slapping 'brains' on your components now

I'VE SADLY NOT been at Computex this year, but over in Taiwan, slapping 'brains' on all your PC components looks like it's the theme of the show. Both Corsair and Hyte are launching new smart control systems for PC builders, which will help us keep tabs on everything that's going on in our systems. That's alongside full cooling and lighting ecosystems, fans, AIO cooling solutions, and RGB lighting strips to match.

Anyone who has used Corsair gear before will be familiar with its iCue software, but its new link hub and cooling ecosystem will feed case fans into a System Hub—a "brain" that controls everything with one wire. What it means is that you'll be able to read not just the system's temperature, but the temperature of each fan individually. It also keeps track of fan speed, and the iCue Link tech means you can jam them all together with proprietary connectors and just one PCIe cable, rather than having cables everywhere.

Hyte's Nexus Link works similarly in terms of the single cable standard, except its fans also come with the addition of orientation sensors, plus proprietary connections that all link up via magnets, which is pretty nifty. Any seasoned PC builder would say you could just look at your fans to see which way up they are, but hey, the Nexus Link tech means you don't have to. I also prefer that Hyte is going for universal hardware support with its software, too, so if you have a favorite keyboard that you don't want to give up, the company won't make you do so in order to get with the RGB pretties, which is nice of them.

The Hyte Nexus Link, out in September.

As Sam says in this month's "Story of the Build" (page 16), cable management is one of his major bugbears when in the process of putting together cover builds. The iCUE Link and ecosystem, including the System Hub, will be coming in June 2023. Hyte will follow with its Nexus Link, and Portal tech in September 2023.

SAM LEWIS

Staff Writer

Being a tech-head, I have to add a little element of technology into every aspect of my life—it's just the way I am! I recently changed cars over to an Audi TT, which came pre-installed with a retro-fitted double-din Android head unit, but it didn't have Apple CarPlay installed. I've been lucky to have had this on my last three cars, so it's a necessity for me now. As an iPhone user (don't hate me), the seamless design of the UI feels natural and works great for me on the road.

To get this working, I had to use an old laptop with an SD card reader—my trustworthy 2014 MacBook Pro came in handy once more. I then had to order an SD card to MicroSD card adapter and install an Apple CarPlay VPK file onto a MicroSD card. Then, I plugged this into the head unit and installed the application across. I had to buy a 'nondescript' Apple CarPlay dongle, along with a Mini-USB to Female USB Type-A adapter. My iPhone would then connect through the lightning cable up into the Apple CarPlay dongle, which would connect to the Android head unit via that Mini-USB to Female USB Type-A adapter. It was a bit of a mess, but after some cable management and hiding most of this under the car's trim, I now have a fully functional Apple CarPlay head unit in my car! It's far cheaper than buying another unit with Apple CarPlay pre-installed, that's for sure.

Editor's Pick: Viewsonic X2-4K

Flat panel technology makes all the headlines. You know, OLED monitors, mini-LED backlights, etc. But none of those come close to a projector for sheer cinematic scale.

PROJECTORS aren't great as multi-purpose displays. You're not going to share a projector across tasks like web browsing, editing a spreadsheet, or gaming. Heck, they aren't even suitable for all types of gaming. You're hardly going to play *Counter-Strike* on a projector.

But boy, does it deliver in the right circumstances. Enter the new Viewsonic X2-4K. It's a lower mid-tier beamer with a particular gaming remit. Priced around $1,700, it's neither a cheap option nor a premium model. It's a little like an entry-level 144Hz 4K gaming monitor. It's got some high-end features, but omits others.

Speaking of 4K, that's exactly what you get here. The point of a projector is having a huge image that fills your field of view, so you want as many pixels as you can get. Fortunately, pixel-shift DLP tech allows for 4K at reasonable prices. Some cinema aficionados sniff at pixel shift technology, given that the native resolution of the DLP chip is 1080p, and the image has to be shifted four times a frame to achieve 4K.

For gaming, you'll need some hefty GPU power—or you would were it not for Nvida's DLSS upscaling technology. It means you can drive this projector with a gaming laptop and get decent results. No, you're not going to be hitting 200 frames per second. This projector is limited to HDMI 2.0 and 60Hz at 4K, though it will do 240Hz at 1080p.

Anyway, once you've seen *Cyberpunk 2077* running at 4K on a half-decent beamer, it spoils you for playing it on any flat panel. The experience is just so much more immersive and dramatic. The same goes for *The Last of Us: Part I*. That's another game that suits projector play.

As a DLP projector, the contrast performance is good, and the 2900 lumens makes for a punchy experience. Just don't go thinking that this projector is suitable for a brightly lit room in the daytime; it absolutely isn't. This is very much a tool for watching stuff at night, or in a room where you have good control of the ambient light.

While we're talking DLP tech, it's reassuring to note that the Viewsonic X2-4K suffers from little of the dreaded rainbow effect. A consequence of the spinning color wheels used by DLP projectors, this isn't something that bothers everyone. I'm pretty sensitive to it, so I'm confident it won't be a problem for the majority of users with this projector.

Slightly less successful are the Viewsonic X2-4K's optics. This is a short-throw projector, so you can achieve a very large image with the projector situated only a modest distance from the projection surface. It's not an ultra-short throw laser model that sits right up under the screen, but you can achieve a 100-inch image with the projector just five feet from the screen.

The less impressive aspect is the absence of lens shift. Okay, that's inevitable at this price point. Lens shift adds significantly to the cost of a projector's optics. But without it, this isn't a hugely flexible projector when it comes to installation. You have to position it in precisely the right spot to get nice, clean image geometry without using the dreaded digital keystone correction.

All that said, the optics aren't bad. It's no problem achieving crisp, accurate focus across the entire image. But if it was my money, and as good as this Viewsonic projector is in many regards, I'd spend a little more for a projector with lens shift and that crucial added freedom when it comes to setup and positioning. **–JL**

$1,699, www.viewsonic.com

© VIEWSONIC, PRIME MATTER, CHATGPT

Reviewed...

74 Intel Core i3-13100F

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80 Alienware X17 R2

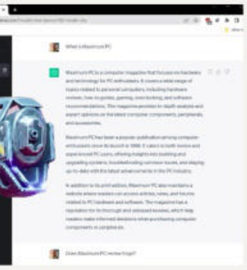
82 Dell 27 Gaming Monitor G2723H

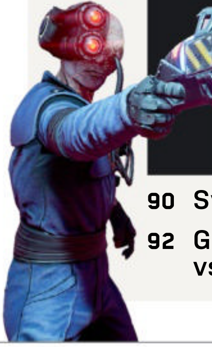
84 Intel Core i5 12300F

87 SteelSeries Apex Pro TKL

88 SteelSeries Arena 9

89 Razer Blackshark V2 Pro 2023





90 System Shock

92 Google Bard vs ChatGPT

INTEL® CORE™ i3
i3-13100F
SRMBV
X249H818

The i3-13100F delivers great performance, although its predecessor offers even better value.

Intel Core i3-13100F

Intel remains the budget gaming king, even if it struggles to beat its previous gen chip

THE INTEL Core i3-13100F comes to market with big shoes to fill; its predecessor, the Core i3-12100F, built a reputation as the best budget CPU for gaming. Intel is looking to repeat that success, but perhaps the Core i3-13100F follows in the footsteps of its predecessor too closely—the company repurposed the previous-gen design for the Core i3-13100, so it has the same four p-cores paired with an ever-so-slightly-improved 200 MHz higher boost clock of 4.5 GHz.

The 13100F addresses the sub-$150 budget segment, so pricing is critical. However, while Intel launched the previous-gen graphics-less Core i3-12100F at $104, it quietly raised pricing. Naturally, that leads to higher prices for the new Core i3 models. As such, Intel's recommended pricing has jumped to $144 for the Core i3-13100 model and $119 for the graphics-less 13100F model. That's a 12 percent and 15 percent gen-on-gen price increase, respectively.

The $119 Core i3-13100F squares off with the $99 Ryzen 5 5500. The AMD chip drops into the inexpensive and plentiful AM4 chipset ecosystem, giving builders plenty of affordable options for budget builds, thus creating a fierce contest for a spot on the list of best CPUs for gaming.

Like its predecessor, the Core i3-13100F comes with four performance cores and eight threads, but no e-cores for background tasks. Intel sprinkled on 200 MHz of extra boost frequency (+5%), bringing it to 4.5 GHz, and 100 MHz higher base clock (+3%), bringing it to 4.3 GHz. The clock speed adjustments are all that Intel has to justify the step up to 13th-Gen branding and the much higher price tag.

As before, the 13100 has a 60W / 89W processor base/max turbo power, 16 PCIe 5.0 lanes, and four PCIe 4.0 lanes, and support up to DDR4-3200 and DDR5-4800 MT/s (caveats apply to DDR5 support). The 13100F drops into either 600- or 700-series motherboards and come with a bundled Laminar RM1 cooler that is sufficient for cooling the chip under normal conditions, albeit at the expense of a higher noise level.

In gaming, the 13100F beats its $110-level competition, namely the Ryzen 5 5500, being on average 8 percent faster in 1080p gaming. However, the 12100F has a very similar 7 percent advantage over the Ryzen 5500 and should be available at around the $100 mark, making it even better value. The 13100F exhibits a more meaningful lead over the 12100F in productivity benchmarks, delivering 6 percent more performance in both single- and multi-threaded applications. However, again the 12100F is the more reasonable choice at its lower price.

If you're looking for a gaming processor for around $100, the $110 Core i3-13100F is 8 percent faster than the $99 Ryzen 5 5500, giving it the win. The Ryzen 5 5500 is also limited to the PCIe 3.0 interface, while the 13100F supports the faster PCIe 5.0/4.0 interfaces. However, while the 13100F takes the lead over the Ryzen 5 5500 in this price bracket, the previous-gen $100 Core i3-12100F remains the chip to beat, with basically the same performance as the Core i3-13100F in gaming, but for $10 less.

Overall, the $110 Core i3-13100F makes sense if you want the latest gen chip, but it faces a stiff challenge from its predecessor, the 12100F. If you're looking for a chip in the $100 price range and you can find it in stock, we still recommend the Core i3-12100F for gaming-focused budget builds. If the Core i3-13100F is all that is available, it is also better in the ~$100 price range than the Ryzen 5 5500. If you're looking to step up a pricing tier and want even more performance in gaming and productivity applications, the Ryzen 5 5600 is the best of the bunch in both gaming and productivity work. That makes the 13100F the clear winner in its $100-ish price bracket, but it faces strong competition if your budget stretches up to $150. **–PAUL ALCORN**

BENCHMARKS

	Intel Core i3 13100F	Intel Core i3 12100	AMD Ryzen 5 5500
Cinebench R23 Single Core (Score)	**1,761**	1,684	1,376
Cinebench R23 Multi Core (Score)	8,946	8,171	**10,770**
Cyberpunk 2077 (fps)	**133**	132	125
F1 2021 (fps)	**185**	**185**	170
Far Cry 6 (fps)	**121**	120	91
Total War: Warhammer 3 (fps)	165	**167**	147
Peak Power Draw (Watts)	**42**	45	56

Best scores are in bold. Our Intel test bench consists of an MSI MAG Z790 Tomahawk WiFi and 2x 8GB Trident Z Royal DDR4-3600. Our AMD test bench consists of an MSI MEG X570 Godlike and 2x 8GB Trident Z Royal DDR4-3600. Both systems used 2TB Sabrent Rocket 4 Plus and Asus RTX 4090 ROG Strix OC for gaming and Nvidia GeForce RTX 2080 Ti FE for applications. All gaming tests were done at 1080p resolution at highest or ultra settings.

VERDICT

7

Intel Core i3-13100F

➕ **CHAMP** Strong gaming performance; Support for DDR4; Support for PCIe 5.0; Single-threaded performance; Sufficient bundled cooler.

➖ **PRETENDER** Higher pricing; Comparatively slow in threaded applications; No CPU core overclocking; Limited memory overclocking.

$119, www.intel.com

SPECIFICATIONS

Architecture	Raptor Lake
Cores/Threads (P+E)	4 / 8 (4+0)
P-Core Base/ Boost (GHz)	3.4 / 4.5
TDP/PBP/MTP	60W / 89W
Memory Support	DDR4-3200 / DDR5-4800
L3 Cache	12MB

Lenovo Legion Y32p-30

Lenovo's premium 4K panel has a pricing problem

FORGET 49-INCH UBER-WIDE monsters, 1080p panels with the kind of refresh rate that gives you a nosebleed, massive OLED screens that are really thinly disguised TVs, or niche 8K irrelevancies. For the discerning PC enthusiast with cash to splash, there can currently only be one monitor choice. Yup, it's a 32-inch 4K panel with a triple-digit refresh rate.

That gives you plenty of on-screen real-estate, decent pixel density for nice, crisp fonts, and good image detail, plus sufficient fluidity and low enough latency that anything faster risks diminishing returns. It's this enticing proposition that the Lenovo Legion Y32p-30 serves up.

At $749, none of this comes cheap. In fact, if anything the Legion feels pricey for what you're getting. Notably, the HDR support is limited. Yes, there's HDR 400 certification, but as that implies, the panel's peak brightness is a mere 400 nits. While there is local dimming, it isn't the full-array flavor with hundreds or thousands of zones. Instead, it's the edge-lit variety, totalling just 16 zones.

Ultimately, that's a checkbox exercise rather than a serious attempt at delivering a true HDR experience. What you're really looking at is a $749 SDR panel, and that's a little bit punchy. What's more, the Lenovo's 32-inch 4K IPS panel is only rated at 90 percent coverage of the DCI-P3 color space. Pretty much every recent display we've seen in this part of the market can hit 95 percent or more.

If that all sounds like an inauspicious overview, it reflects the reality that monitor specs can be misleading, because the Lenovo Legion Y32p-30 is a very nice display. For starters, it's beautifully built, with a high-quality chassis and stand, albeit accompanied by slightly fussy design cues. It's also well equipped, with DisplayPort 1.4, two HDMI 2.1 ports, and a USB-C interface with power delivery enabling single-cable docking functionality. There's even a KVM switch to make sharing this display across dual PCs a cinch.

As for visual performance, it won't fry your retinas with pure optical sizzle, but a quality IPS panel with a decent backlight, a 4K pixel grid, and 144Hz refresh is still a pretty special experience. It's quick, too, with the middle of three overdrive settings returning very quick response and little visible overshoot. Sure, OLED panels are far faster on paper, but the subjective gap isn't all that big. You'd have to be a serious esports type to find the Legion Y32p-30 deficient in terms of response or latency.

You wouldn't have to be so picky, on the other hand, to take issue with the HDR performance. Whether during gaming or video playback, the HDR experience is dull, especially if you've had your expectations recalibrated by the latest QD-OLED monitors. Again, this isn't truly an HDR monitor; the market pretty much dictates basic HDR support at this price.

This brings us back to the Lenovo Legion Y32p-30's one significant issue: pricing. For $750, there's a lot of choice these days. For gaming, you're not far off Alienware's cheaper 34-inch ultrawide QD-OLED pairing. In the opposite direction, you can often find 4K 32-inch 144Hz IPS monitors for under $600.

If you're happy with the slightly slower response of VA, you occasionally see similar displays available for under $500. All told, it would be easier to recommend the Lenovo Legion Y32p-30 were it priced anywhere from $500, which is as low as you could hope for, to around $650. As it is, this is a nice all-round 4K display, but one you probably wouldn't pick over cheaper alternatives. **–JEREMY LAIRD**

VERDICT

8

Lenovo Legion Y32p-30

+ ROMAN LEGION Gorgeous IPS 4K panel; Really nice build quality.

− FOREIGN LEGION Pricier than the competition; Limited HDR support.

$749, www.lenovo.com

SPECIFICATIONS

Panel size	32-inch
Panel type	IPS
Resolution	3840 x 2160
Brightness	350 nits, 400 nits peak
Response time	0.2ms MPRT
Refresh rate	144Hz
Contrast ratio	1000:1
Features	IPS panel, 90% DCI-P3, Freesync Premium, 1x DisplayPort 1.4, 2x HDMI 2.1, USB-C, KVM switch

© UNSPLASH

DisplayHDR 400
AdaptiveSync
eyesafe
FreeSync Premium
Lenovo

Lenovo's latest ticks all our 4K, IPS, 32-inch, 144Hz boxes.

A very clean, minimal, and professional design from Dell.

Dell 24 Monitor P2423D

Another QHD productivity delight or misfire?

© UNSPLASH

WHEN SELECTING a monitor, there are many different features to choose between. These include resolution, screen size, refresh rate, response time, color range, panel type, brightness, contrast, connectivity, and more. It's important to know what features you need—for instance, a gamer would probably prefer a high refresh rate and response, while a designer or creative would be more worried about color actuary, panel type, and connectivity. The QHD Dell P2423D appeals to the latter, favoring productivity over gaming.

Before we get into the nitty-gritty, this is a handsome display. It doesn't take long to realize that this is a premium-end product for the creative market—there's no crazy RGB madness going on here! The stand feels sturdy, and is finished in brushed aluminum. It has a swivel angle of 90 degrees, has 5.9 inches of height adjustment, and a tilt angle of -5/+21.

The screen itself isn't quite 24 inches; to be precise, it's 23.8 inches. It's a great size for a desk—not too big, not too small. It comprises three very thin bezels, with the chin of the display being slightly thicker. The thin bezels help remove any distractions and improve immersion. Other than that, there's not much else going on at the front of the display, and that's not a bad thing. Its minimalistic design is great for versatility—it will fit into most office spaces or home offices.

The ports are on the back—unfortunately, there's only one HDMI port and one DisplayPort. It's not the end of the world, but if you wanted to use this display with multiple devices, this could pose a problem. Thankfully, there are lots of USB ports: four SuperSpeed USB 5 Gbps (USB 3.2 Gen1) Type-A downstream ports, to be exact.

After a few setting adjustments, we hooked it up with the PC we built on page 16. After booting up some productivity tools, such as Adobe Premiere Pro, InDesign, and Photoshop, it was clear where this monitor stood out. At its maximum resolution of 2160 x 1440, it produced a strikingly clear image with fantastic color accuracy (99 percent sRGB coverage). Its IPS display achieved vivid shades, deep blacks, and decent viewing angles. It also retains a PPI of 123 at a QHD resolution. For a desktop, anything between 110 and 140 PPI will provide a crisp contrasting image, especially at this resolution and screen size.

Another great feature is ComfortView Plus. This is always on, and manages to keep the fantastic color accuracy of the display while reducing blue light levels. Seeing as this is made for creatives, the last thing they'd want when working on a long project is eye strain, so features like this help to keep you working for longer.

Despite the screen size being a great format for a QHD display, with a high PPI for creative design work, the real estate isn't as impressive, which leads us on to one of the main issues. Is it worth spending more of your budget to get an ultra-wide monitor, or is this monitor better when doubled up? We tend to lean towards the latter, as design-wise, it's very minimal with its thin bezels, so would suit a dual-monitor setup. By doing that, you'll be spending around $670, which is slightly above what we'd want to pay. Otherwise, this display is very impressive. For video editing, photo manipulation, and even day-to-day work, it's very dependable—it'd just be even better in a dual-screen setup. **–SAM LEWIS**

VERDICT

8

Dell 24 Monitor - P2423D

+ **GLEAMING** QHD resolution; Strong PPI; Deep color range; Professional design.

− **UNPOLISHED** Only 1 HDMI port; 300 nits of brightness; Better suited doubled up.

$334.99, www.dell.com

SPECIFICATIONS

Panel size	23.8-inch
Panel type	IPS
Resolution	QHD 2160 x 1440
Refresh rate	60Hz
Response time	5ms
Brightness	300nits
Contrast	1000:1
Pixel per inch	123
Color gamut	99% sRGB
Connectivity	1 x HDMI (HDCP 1.4), 1x DisplayPort 1.2 (HDCP 1.4), 1 x USB Type-A 3.2 Gen 1 (upstream), 4 x USB Type-A 3.2 Gen 1 (downstream), 3.5mm auxiliary jack

A strikingly sleek design
for a monstrous laptop.

Alienware X17 R2

Is last-gen power still relevant?

NEW PRODUCTS and advancements are coming out quicker than we can comprehend, so we may overlook slightly older products. In reality, there are plenty of last-gen devices that are more than capable of turning back the clock. This model of Alienware X17 R2 boasts some powerful innards, but can it still prove to be a competitor in the current gaming laptop market?

Due to its 17-inch display, this is a behemoth of a laptop, but Alienware has done a great job of disguising this by giving it a sleek design. The color scheme is a classy matte white outer with matte black inside. Coated in a soft-touch plastic finish, it also evades the cheap feel you might associate with plastic. There is barely any flex, creaks, or screen wobble, giving it a premium edge, and it's heavy, weighing nearly seven pounds. A 17-inch laptop was never going to challenge a 13-inch ultrabook for portability or practicality; it's designed to be used on a desk with desktop PC comparable performance, and the option to move it around if necessary.

On the lid, it features an RGB Alienware logo and the number 17, as if you'd forget what size your display was! The hinge isn't directly at the back of the laptop; it's half an inch from that, which gives the display all of its rigidity. The chin at the back also provides stability—this isn't sliding anywhere. It also houses a healthy amount of ports, aside from the 3.5mm jack, which is found on the right, and the AC port on the left. On the flip side of the lid is one of the main showcases of this laptop, the screen itself. It's an IPS display with a 16:9 aspect ratio, 3ms response time, and a 120Hz refresh rate making it smooth enough for 4K gaming. Just bear in mind the RTX 3080 Ti will struggle to reach 120fps at 4K resolution in a lot of modern games.

This screen pushes a wide range of deep colors and sharp contrasts, and looks fantastic when gaming. Its thin bezels help to keep you immersed in the experience. It's also a great setup for desktop gaming. We recommend picking up a laptop stand to elevate the display and help with ventilation, though. Below this screen is a fantastic keyboard/trackpad combo. It's a joy to type and game on, with deep key travel but fast actuation speeds, especially for a laptop. The trackpad is large and responsive, which makes it perfect for work tasks.

So internally, what's being offered? We've already mentioned one of the main components, the RTX 3080Ti. This card is still a great feature on any system, and rewards you with smooth gaming at ultra settings—just not at the native 4K resolution. We'd prefer to turn it down to either QHD or 1080p just to improve the frame rate. We did this on *Total War: Warhammer III*, and our frame rate increased from 36 fps @4k to 105 fps at 1080p. Despite the drop, it still looked great, as the settings were still at Ultra, and it ran much smoother.

Paired with the GPU is the Intel i7-12700H—again, a very competent component. Everything is very snappy, and it can handle a multitude of tasks. Although it's not the latest from Intel, it still uses the hybrid architecture, splitting its 14 cores into 6 performance and 8 efficiency cores, and has a max turbo frequency of 4.70 GHz. Our configuration also has 32GB of DDR5 RAM at 4800MHz, and a pleasant 2TB Samsung PM9A1 PCIe 4.0 SSD.

All of these components make one heck of a powerful package, but at what cost? An expensive one—even though it doesn't feature a 13th gen chip or an NVIDIA GeForce RTX 40 series, its price would suggest otherwise. This configuration comes in at $3,499. That's too much money, especially for this specification. RTX 4090 laptops can be picked up at this price.

The bottom line is that this laptop is great—just not at this price tag. A price reduction would seriously boost its appeal, as it's really the only issue with this X17 R2. **–SAM LEWIS**

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	2,078	1,655 (-20%)
Cinebench R23 Multi-Core (Index)	29,416	15,608 (-47%)
CrystalDisk QD32 Sequential Read (MB/s)	7,336	6,387 (-13%)
CrystalDisk QD32 Sequential Write (MB/s)	6,451	5,048 (-22%)
3DMark Fire Strike Extreme (Index)	31,689	14,151 (-55%)
Cyberpunk 2077 (fps)	75	31 (-59%)
Cyberpunk 2077 RTX (fps)	48	17 (-65%)
Metro Exodus (fps)	73	39 (-47%)
Metro Exodus RTX (fps)	41	25 (-39%)
Total War: Three Kingdoms (fps)	69	36 (-48%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the 4K Ryzen PC from our April 2023 issue, featuring an AMD Ryzen 9 7900X, ASUS Radeon RX 7900XT TUF Gaming OC 20GB, ASUS TUF GAMING X670E-PLUS WIFI, 32GB (2x16) of Team Group T-Force Delta TUF Gaming Alliance RGB DDR5-4800, and 1TB Solidigm P44 PCIe 4.0 M.2 SSD. All games tested at 4K 'Ultra' graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking.

VERDICT
7

Alienware X17 R2

⊞ HOLDS UP WELL Fantastic build quality; Well-rounded gaming experience; Still has great longevity.

⊟ TIME WILL TELL Very expensive; Last gen; Poor battery life.

$3,499, www.dell.com

SPECIFICATIONS

CPU	Intel Core i7-12700H @4.70GHz
Graphics	NVIDIA GeForce RTX 3080 Ti 16GB GDDR6
RAM	32GB DDR5 @4800Mhz
Screen	17.3" 4K (3840 x 2160) IPS @ 120 Hz
Storage	2TB Samsung PM9A1 M.2 PCIe 4.0 SSD
Ports	2x USB 3.2 Gen 1 Type-A, 1x USB 3.2 Gen 2 Type-C, 1x Thunderbolt 4, 1x HDMI 2.1, 1x Mini DisplayPort 1.4, 1x RJ45 Ethernet, 1x 3.5mm Audio Jack, 1x microSD-card slot.
Weight	6.69 lbs
Size	0.8 x11.8 x 15.7 inches

Behind its sleek design lurks some mighty performance.

Dell 27 Gaming Monitor G2723H

Is 1080p all you really need?

© GETTY IMAGES

WE'RE SWITCHING sides now from the productivity-based Dell 24" P2423D monitor (page 78) to a gaming model. If refresh rates, response times, connectivity, and features such as Nvidia G-Sync are more your thing, then this 27" G2723H should suit your needs. Despite the P2423D having a visually stunning display, the 5ms response time and 60Hz refresh rate aren't going to help you much if you plan on jumping into a *Call of Duty: Warzone* lobby.

Visually, you can distinguish the differences between the more gamer-focused displays Dell has to offer and the productivity-based ones. There is a lot more plastic here than we found on the Dell 24" P2423D, which featured a fancy brushed aluminum stand. This isn't necessarily a bad thing, as you don't want the display's stand to stick out too much or cause distractions. Unlike the other model, this has a gunmetal gray stand, which is slightly more angled. This gives it a smaller footprint on the desk, though it's very grippy and won't move around.

Moving up from the stand, you can see the Dell logo sitting proudly on the chin of the display finished in chrome. Talking of the chin, it's very thin, but not quite as thin as its other three remaining bezels. It gives a very minimal impression, which is what you want from a display at the end of the day—your main focus is on what's happening on the screen, not the design.

Dell has clearly paid attention to what matters the most: performance. By default, this 1080p display offers a 240Hz refresh rate out of the box. This is an optimum combination for competitive gamers, who don't require the highest resolution, but do care about super-fast refresh rates. We were more than impressed by the default 240Hz option, but after some digging around in the settings, we found that you can overclock this to 280Hz! True, there are even faster monitors coming down the line that were shown at this year's CES, but with a 0.5ms response time, this is still a seriously quick display.

Going back to the resolution, 1080p for a 27-inch monitor is a great fit. If you wanted a larger monitor, we'd suggest bumping up the resolution to QHD or 4K, but you need the PC performance to match it. Here, at 1080p, you'll be more likely to crank up the settings of your games internally and get a much smoother image.

Talking of the image, this screen has a PPI of 81—a respectable amount at this resolution and size to provide strong sharpness and contrast. In terms of contrast, it's rated at 1000:1, meaning the full white is 1,000 times brighter than the full black. It's a strong performance, and provides bold contrasting colors.

This certainly gives the user a velvety-smooth experience when gaming, or even just everyday tasks. Whenever you move from 60Hz upwards, it's hard to go back and not notice the difference, especially at 280Hz. With features such as Nvidia G-Sync and AMD FreeSync to eliminate screen tearing, input lag, and stuttering, the gaming experience is also seamless. It's also worth mentioning that the monitor has a healthy port selection, making it great for use with both PCs and games consoles.

At a shade over $300, it's not the cheapest monitor, but you get fantastic performance, sharp contrast, and rich colors. Maybe a higher-resolution option would be better for some, as you could still play at 1080p if necessary, but all being said, it's a great monitor choice for gamers. – **SAM LEWIS**

VERDICT

9

Dell 27 Gaming Monitor G2723H

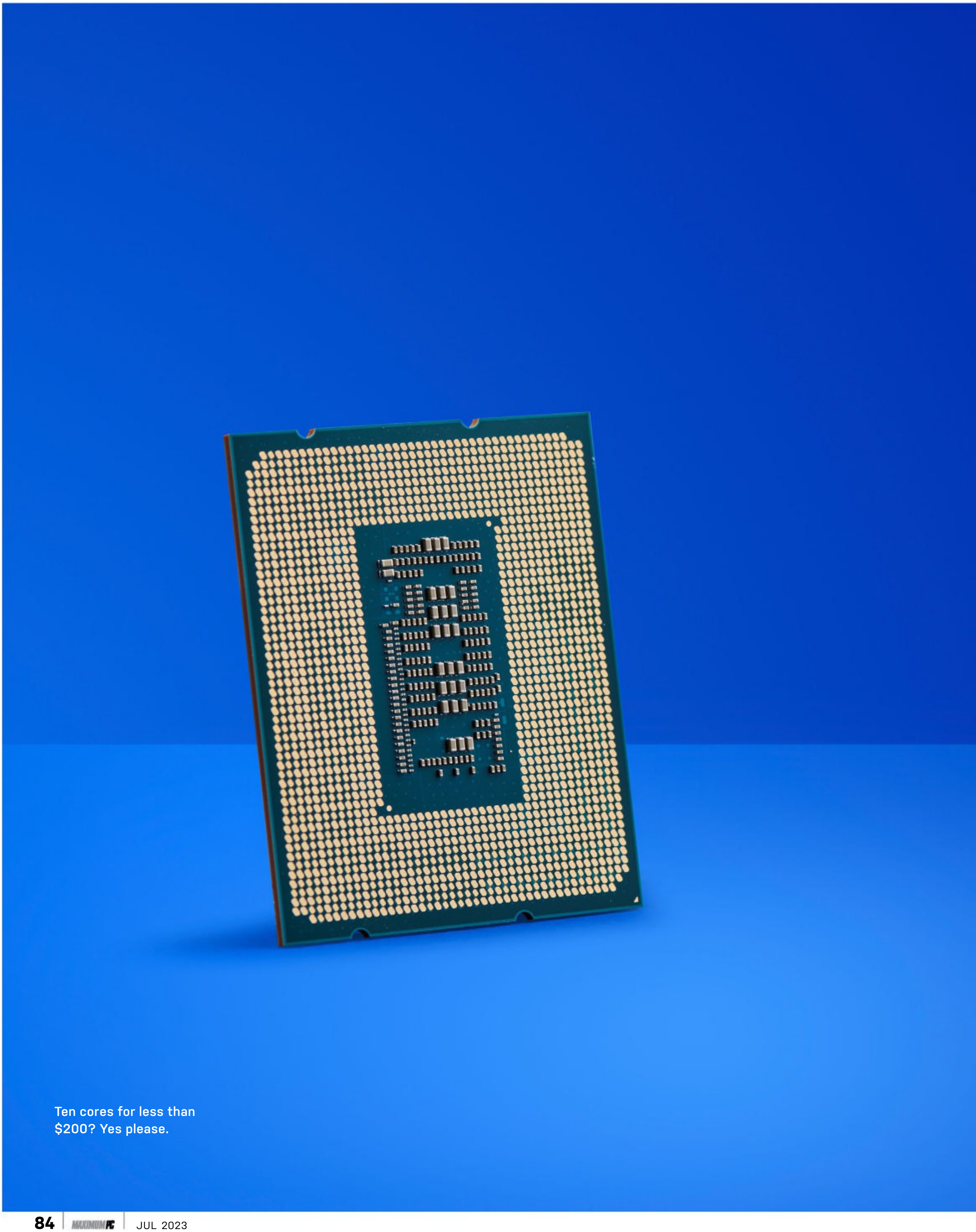
➕ **SUPER SNAPPY** Lighting refresh rate and response time; Strong contrast ratio; Good port selection.

➖ **LIMITED RESOLUTION** FHD only

$309.99, www.dell.com

SPECIFICATIONS

Panel size	27-inch
Panel type	Fast IPS
Resolution	FHD 1920 x 1080
Refresh rate	280Hz
Response time	0.5ms
Brightness	400nits
Contrast	1000:1
Pixel per inch	81
Color gamut	99% sRGB
Connectivity	1 x HDMI 1.0, 1x HDMI 2.0, 1x DisplayPort 1.4, 1x USB-B Upstream, USB-A 3.2 Downstream (BC 1.2), 2 x USB Type-A 3.2 Gen 1 Downstream, 3.5mm auxiliary jack



Ten cores for less than $200? Yes please.

Intel Core i5 13400F

The best budget gaming CPU right now

FOR MOST OF 2022, we recommended the Core i5 12600K for the best gaming CPU, and the Core i5 12400 as the best gaming CPU on a budget. Last year, the Core i5 13600K took over the top spot. Today, the Core i5 13400F pushes Alder Lake out of the runnings with an even more impressive specification for the money.

The Intel Core i5 13400F is a processor I've been waiting patiently to test since I first heard wind of it last year. You'll understand why once you read these specs: A 10-core processor made up of six Performance-cores (P-cores) and four Efficient-cores (E-cores), the Core i5 13400F has a total of 16 threads. Its fastest cores will run up to 4.6GHz out of the box—a clock speed that wouldn't have seemed out of place on the box of a Core i7 only a few years back.

For that spec, the Core i5 has been given an Intel-recommended price tag of $196. Consider the other options: that's a handful of dollars more than the Core i5 12400 from last year, or $33 cheaper than AMD's Ryzen 5 7600. The Core i5 13400F is only a handful of frames shy of the Core i9 13900K in *Total War: Three Kingdoms*, *Metro Exodus*, and *F1 2021*. In *Far Cry 6*, this chip is significantly slower than Intel's high-end processors, however, showing *Far Cry 6* to be a more CPU-limited game than the others. To a lesser extent, the same is true for *Shadow of the Tomb Raider*. But even in these two games, where the Core i5 13400F falls off the pace of the faster 13th Gen processors, it remains quicker than last year's best gaming CPU, the Core i5 12600K. It's also significantly faster than the Core i5 12400, though more power-hungry for it.

The Core i5 13400F doesn't support BCLK overclocking, however, and that was something we adored about the Core i5 12400. Intel blocks multiplier overclocks with all but its K-series chips, meaning neither the Core i5 13400F or Core i5 12400 should have been able to do it, but a few motherboard manufacturers made BCLK overclocking available to non-K 12th Gen processors. With one such overclock at 4.8GHz, the Core i5 12400 manages to top the Core i5 13400F in some games. That said, we'd still take the Core i5 13400F for the extra cores, even if it meant giving up the illicit overclocking capabilities of its predecessor.

AMD has a competitive stack of Zen 4 chips to compete with Raptor Lake today. While its 3D V-Cache chips look set to be the most competitive versus Intel, they're far too pricey for comparison with this Core i5. Instead, the i5 13400F is going head-to-head with the Ryzen 5 7600X, a $299 chip that's more like $250 in today's market, and the $229 Ryzen 5 7600.

In our testing, neither the Core i5 13400F or Ryzen 5 7600X can claim an outright win across the testing suite, though when AMD's chip is faster, it is quite a bit faster. AMD's chip does come out as the clear winner on the productivity and content creation side of things, but it is that much more expensive for it. AMD-compatible motherboards also fall on the expensive side versus the cheaper Intel-compatible 600-series boards, so overall costs will probably tack on around $100 more for the X-series AMD option. That said, the Core i5 13400F is around $210 on Newegg at time of writing, and the Ryzen 5 7600 is only $229.

There's a lot to like about this processor, from its speedy gaming performance to the 10 cores under the hood—enough to make any older four-core CPU feel outdated. While the Core i5 13600K remains the pick for the best gaming CPU, and AMD is competitive in the ~$275 market, Intel's Core i5 13400F is a shoe-in for the best budget gaming CPU in 2023. **–JACOB RIDLEY**

VERDICT
9

Intel Core i5 13400F

➕ **BUDGET BONANZA** Superb gaming performance; Ten cores; High clock speed; Cheap motherboards available.

➖ **CUTTING CORNERS** Higher power draw than 12th Gen model; No secret overclocking; AMD's cheapest Zen 4 CPUs best for content creation.

$196, www.intel.com

BENCHMARKS

	Intel Core i5 13400F	Intel Core i5 13600K	AMD Ryzen 5 7600X
Cinebench R23 Single Core (Score)	1,726	**1,960**	1,930
Cinebench R23 Multi Core (Score)	12,288	**24,055**	15,102
Total War: Three Kingdoms (fps)	209	**213**	203
F1 2021 (fps)	191	**193**	173
Far Cry 6 (fps)	130	**171**	146
Shadow of the Tomb Raider (fps)	188	210	**219**
Max CPU Temperature (°C)	**49**	72	90
Peak Power Draw (Watts)	**110**	147	111

Best scores are in bold. Our Intel test bench consists of an Asus ROG Strix Z690-F Gaming WiFi and 2TB Sabrent Rocket 4.0 Plus. Our AMD test bench consists of an ASRock X670E Taichi and 1TB WD Black SN850. Both systems used G.Skill Trident Z5 Neo DDR5-6000 CL30 2x 16GB and Nvidia RTX 3080 10GB. All gaming tests were done at 1080p resolution at highest or ultra settings.

SPECIFICATIONS

Cores (P+E)	6+4
Threads	16
L3 Cache (Smart Cache)	20MB
L2 Cache	9.5MB
Max P-core Turbo frequency (GHz)	4.6
Max E-core Turbo frequency (GHz)	3.3
Unlocked	No
Graphics	No iGPU
Memory support (up to)	DDR5 4800MT/s, DDR4 3200MT/s
Processor Base Power (W)	65
Maximum Turbo Power (W)	148

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SteelSeries Apex Pro TKL Wireless

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A compact, fast-paced keyboard that focuses on swift switches

THE STEELSERIES Apex 9 TKL was a keyboard that certainly had something going for it, but was let down by not making the most out of the optical switches it came installed with. Naturally, SteelSeries released the Pro variant to hopefully resolve this issue, and that's what we have here—the SteelSeries Apex Pro TKL Wireless. This board comes with more adjustable magnetic switches (yes, there is a difference), for swifter speed. Does this Pro and wireless variant warrant the increased price tag?

Kicking things off, we have to mention the performance of this board and its stand-out trait, the speed. The actuation can be adjusted anywhere between 0.2mm and 3.8mm, in increments of 1mm. For us, it's as far as we'd like to go in either direction. Something as tiny as 0.2mm is extremely sensitive to the touch, which makes it great for gaming, but less so for day-to-day typing. This extremely snappy actuation means you barely have to press the key in order for it to trigger. It not only saves you time, but ensures that the key resets quicker in time for another actuation, making it handy for any game that requires you to press keys in quick succession. Another great feature here is dual actuation. This means you can set any key to offer two functions depending on how hard you press it. It takes time to get used to, but can be great once you've implemented it to your playing style.

Setup for this keyboard was very convenient. Using the SteelSeries Engine application, it didn't take too long to set up various profiles so you can switch between gaming and typical usage. On the keyboard, you only need to press and hold on the SteelSeries logo key (a replacement for the Function key) and hit F9 to cycle through the available profiles loaded onto the board. Each profile can have an image associated with it, which leads us to one of the main quirks of the board—its mini OLED display. This is nothing new to SteelSeries, but we still love the retro-themed displays they cram into all sorts of peripherals. They're both surprisingly handy and give character to your devices. You can upload just about any image to the SteelSeries Engine, and it'll estimate it into the OLED's low pixel pitch, sometimes with horrifying results!

PAYING THE PRICE

One thing that we were quick to turn off in the Engine application was the keyboard's default sleep timer. Set to five minutes out of the box, this was far too short, as some SteelSeries gear can be pretty slow to wake up, especially if it's not got the strongest connection to the dongle. This default setting will be favorable for the battery life, but after nearly a week of use, we still had 50 percent juice remaining—pretty impressive!

Let's get to the price, because this isn't the cheapest. At $250, it's really up there for a keyboard of its diminutive size, and going against the fantastic ASUS ROG Azoth for the same money. It's a similarly designed keyboard, but unfortunately for the Apex Pro TKL Wireless, it doesn't win that fight. The SteelSeries focuses on speed and special switches, while the Azoth is more of an enthusiast's high-end product. As the SteelSeries Apex Pro TKL is "ten-keys-less", we are missing out on a numpad here, too. It's one of the most popular choices for gamers, but when you want to switch over to work or just procrastinate, for example, it can be frustrating. Yet it makes up for this with its very practical and portable size.

The biggest issue is how much more you have to pay for this wireless version—around $60 more than the wired variant. If the wireless functionality is a must-have then that's a premium you can't always avoid, but for most, the wired version will suffice. The build quality is impressive, much like the high standard set by the majority of SteelSeries's lineup, yet for the price, it's still a little too much.

Overall, it's an impressive keyboard, that features some very speedy keys, dual actuation modes, and up to five onboard profiles, and it utilizes its switches well. Unfortunately, though, we're ultimately leaning toward the wired version as the better buy. **–JACOB RIDLEY**

VERDICT
8

SteelSeries Apex Pro TKL Wireless

+ PRO Simple profile switching; Useful OLED; Adjustable actuation; Good battery life; PBT keycaps.

− NO A cheaper wired version is available; Sleep mode is too aggressive out of the box; Stiff competition.

$249.99, www.steelseries.com

SPECIFICATIONS

Switch Type	SteelSeries OmniPoint Adjustable Mechanical
Switch Durability	100 million presses
Design Style	TKL
Adjustable Actuation Points	0.2-3.8 mm
Connection	Detachable USB Type-C, 2.4 GHz, Bluetooth
Battery Life	37.5 hours (Wireless), 45 hours (Bluetooth)
Wrist-rest	N/A
Weight	2.40 lbs

SteelSeries Arena 9

Are the world's first 5.1 surround sound gaming speakers a necessary addition to your setup?

EVEN THOUGH we'd be lost without headphones for work, music consumption, gaming, and relaxing, it's great to have both a reliable pair of cans and a solid speaker solution. Say, for instance, you're relaxing before you go out for dinner, the last thing you want to be walking around with is headphone hair. We've all been there—it's nearly impossible to remove that dent! So what better way to compensate than with a powerful pair of speakers? The Arena 9 from SteelSeries is the range-topping model and aims to be an all-in-one solution for at-home use. Can they deliver a fantastic soundstage, look the part, and fit easily within your setup at home?

Sitting at the top of the SteelSeries hierarchy above the Arena 3 & 7, the 9's offer the most amount of tweeters and the largest sound. Of course, as the models increase, so does the price, and these come in at a cent under $550. That doesn't make these budget end, but it does make them a much more permanent fixture to your setup. In the box, you get a heck of a lot to unpack, but we have to say, it is very well packaged. Each speaker and component comes in its own cardboard compartment and numbered bag, making setup easy.

Inside, you get a front left and front right speaker, center speaker, rear left and rear right speaker, subwoofer, OLED control pod, and power cables. The initial setup is worth taking your time with, as you want to make sure you get the speakers all in the correct location, and also make sure that you can keep the cable management side of things under control. It is pretty self-explanatory, with the name of the speakers giving the game away to where they should be located. They also aren't too large, so they should fit the majority of typical desktop PC setups. You only need the front left, front right, and center speaker on your desk, the subwoofer is best placed on the floor, and the rear right and rear left speakers should be located behind you.

SIGHT AND SOUND

Aesthetically speaking, the design follows more of a curvaceous theme than more traditional boxy monitor speakers, but this fits the SteelSeries look to a T. These speakers have a soft plastic design and feel great to the touch—not that you'll be handling them much, but it's still a sign of good quality. To lighten the design, they feature RGB lighting, controllable by the SteelSeries Engine application. These lights are found on the back and the base of the two front left and front right speakers. They're subtle enough not to distract you from gaming, but are bright enough to add a nice ambient glow.

One other impressive feature is the control pod. This is essentially an OLED dial that houses the controls such as volume, EQ control, output modes (as this dial has a 3.5mm jack), basic lighting controls, and more. It looks fantastic with a retro-inspired 8-bit menu—nice touch, SteelSeries.

So it's all great so far, but how do the SteelSeries Arena 9s sound? Well, these speakers produce incredibly punchy audio, more than enough to fill your room full of atmospheric immersion as they feature true 5.1 surround sound. They work especially well when gaming on any *Battlefield* titles, *Cyberpunk 2077, Call of Duty Modern Warfare 2*, or any similar title which benefit from big sound. It adds so much more feel to the game—you can quite literally feel most explosions and shots from the subwoofer!

These speakers produce a vastly wide soundscape, with detailed highs that sit above a very solid midrange sound so that the bass doesn't overpower the overall sound. EQs can be adjusted within the SteelSeries Engine and we recommend going for the classic Smiley configuration here to get the most detail out of these. Of course, for competitive gameplay, a pair of headphones will always be the most accurate solution, but if you want to kick back, relax, and experience your games in full comfort, you can't go wrong with the Steel Series Arena 9's—although they are a little pricey! **–SAM LEWIS**

VERDICT

9

SteelSeries Arena 9 Speakers

+ ARENA FILLING SOUND Huge detailed soundscape; Punchy bass; Wide compatibility; Great build quality.

– MINOR ISSUES Pricey kit; Not 7.1 surround sound.

$549.99, www.steelseries.com

SPECIFICATIONS

Speakers	Front Speaker (Left & Right), Center Speaker, Rear Speaker (Left & Right), Subwoofer
Driver Material	Organic fiber and silk
Frequency Response	35-20,000 Hz
Sensitivity	89 dB
Compatibility	Windows, Mac OS X, PlayStation, Bluetooth, Audio devices with Optical or Stereo 3.5mm connection
Connectivity	USB Type-A to USB Type-C, Bluetooth 4.2, Auxiliary, Optical

Razer Blackshark V2 Pro 2023

A genuine 2023 upgrade, but the original still sounds great for less

THE RAZER BlackShark V2 Pro 2023 is a sort of mid-generation update to its original V2 Pro. But really, we'd have probably forgiven it for slapping on a V3 moniker, as Razer has genuinely improved on what is still one of our favorite wireless gaming headsets. The issue for Razer is that the original V2 Pro is still being sold by the bucketload, and getting on for nearly $100 less than the newer cans. Another problem is that the 2023 version's pricing brings it $100 away from our beloved Audeze Maxwell headset, which we think is the best wireless headset going.

The quality of life updates are likely the first things you'll notice about the new BlackShark V2 Pro 2023, such as the USB Type-C connection, tweaked volume knob, and an added audio profile switch button on the right ear cup. One of the benefits of that Type-C connection is that it's able to offer fast charging of the headset. You now get a reported 70 hours of battery life out of the new V2 Pro, which is on the 2.4GHz wireless connection, and some 90 hours if you stick to a Bluetooth 5.2 connection. A 15-minute charge nets you up to six hours of game time.

In terms of comfort, Razer has also added a little extra padding to the headband, and reportedly fixed up the fitting adjustment sliders on either side of the frame. Razer had a few issues with those breaking over time with the previous version of the V2 Pro, and so has added a little strengthening to the perceived weak point.

The wireless connection is rock solid, as was the original V2 Pro, but I will say it's a touch disappointing to be without the option to use a 3.5mm audio cable as Razer has pulled that option from this 2023 update. It's only a small thing, but it does cut a little of the versatility of the headset. Still, wireless audio is why you pay the big bucks for a V2 Pro, so we can't be too upset to lose the analogue option.

Razer has also removed the need to have its Synapse software running on your system. I can sense the reflected joy from that statement; I too have felt the pain of Razer's sometimes painful, often intrusive software ecosystem. This 2023 edition comes with a set of audio profiles built into the headset itself, accessible from that new profile switch on the side. A long press of which also cues up some pro-tuned, per-game profiles for *Apex Legends*, *Call of Duty*, *CS:GO*, *Fortnite*, and *Valorant*.

Impressively, this 2023 update comes with a great headset mic. That's a welcome trend in modern gaming headsets, and I'm glad Razer is getting on board, because the mic on the OG version was pretty ropy. The mic is still detachable, but it's been enhanced. For one, the actual boom arm itself is more rigid and should stop it drifting away from your mouth over time, but the actual quality has been stepped up—a lot. It's rocking a 32KHz sampling rate, but also manages to cut out a whole load of background noise while it's at it.

The overall sound quality hasn't changed, by which I mean it's still excellent. I was always a big fan of the Razer TriForce drivers since the original BlackShark V2, and their appearance in the V2 Pro and this 2023 update make just as much of an impact. They're clear, tight, and deliver a genuinely impressive and immersive soundscape for a closed back set of cans.

I still think the Audeze Maxwell wireless headset, with its gorgeous planar magnetic drivers, is the pinnacle of cable-free gaming headphones, but that's also another $100 more expensive than the new BlackShark V2 Pro. But at $200, it's not like this 2023 edition is cheap. If you can find it, I'd buy the original V2 Pro headset for $120, but the 2023 version is still worth getting in its own right. **–DAVE JAMES**

VERDICT
8

Razer Blackshark V2 Pro 2023

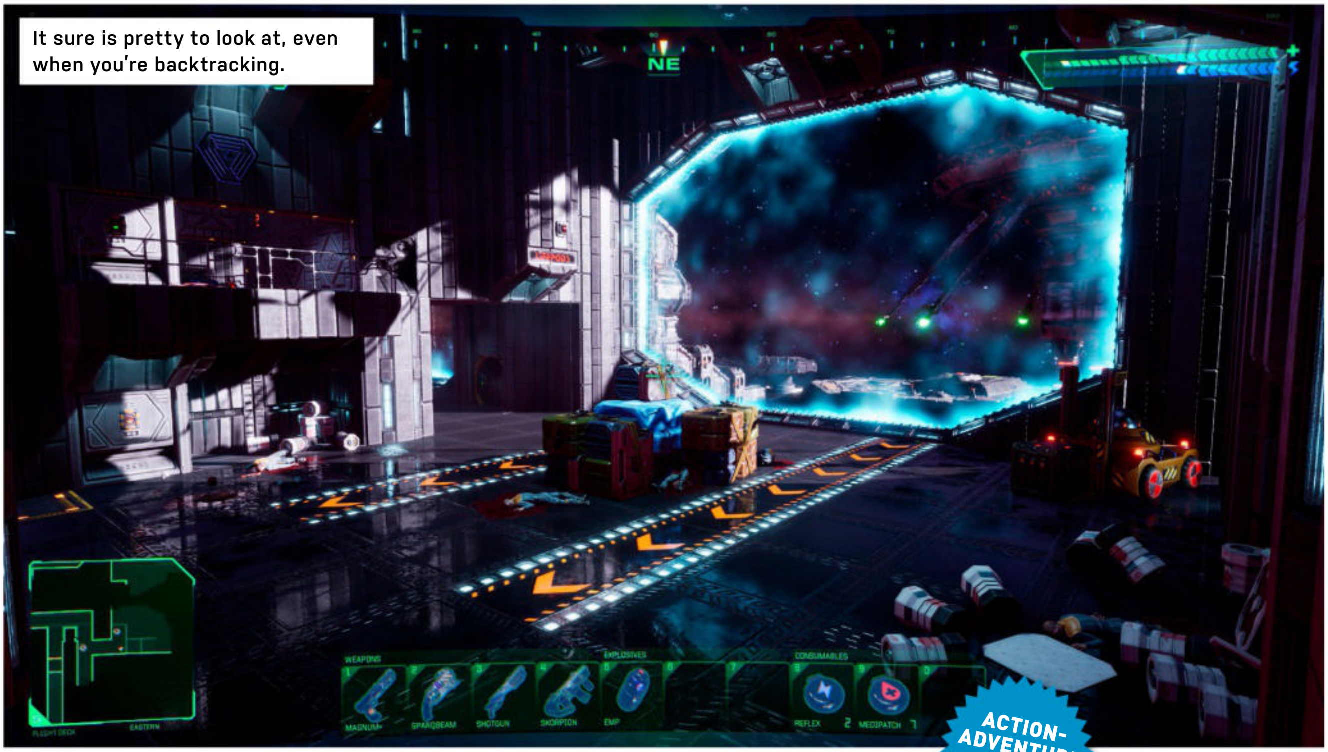
+ SLAPS TriForce drivers sound great; Excellent mic; Solid wireless; Great battery life.

− CRAPS Original V2 Pro is cheaper and still being made.

$200, www.razer.com

SPECIFICATIONS

Operating principle	Closed back
Drivers	50mm dynamic TriForce Titanium
Frequency response	12 - 28,000Hz
Connection	2.4GHz, Bluetooth 5.2
Noise cancelling	Passive
Microphone	Detachbable super wideband
Pickup	Unidirectional
Battery life	70 hours (2.4GHz), 90 hours (Bluetooth 5.2)
Weight	320g



It sure is pretty to look at, even when you're backtracking.

ACTION-ADVENTURE GAME

System Shock

Nightdive has modernized the original, although it might have stuck too faithfully to its formula

LET ME TELL YOU about the one that got away. She was pitiless and cruel, narcissistic and delusional. She unfurled through Citadel Station in a thousand security cameras and as many cyborg slaves, their meat taken from the bodies of the outpost's former staff. She made pustules and blisters, mutants and monsters. She was the death of me a million times over, and I've missed her more than words can say.

She is SHODAN, the malevolent AI goddess who was the centerpiece and proudest creation of 1994's *System Shock*, rebuilt in sparkling Unreal Engine 4 in this remake from Nightdive Studios. Gone are the sprite-based enemies and screen-eating UI from the original game, replaced by clanking, three-dimensional automatons and an inventory that—while not exactly sleek—is certainly easier to use than the original's rolling shopping list of weapons, explosives, and stimulants.

Both *System Shock* and SHODAN are legendary; iconic symbols of an era and philosophy in game design, and remaking them must have been a daunting task. How do you change-up the game that first used the 451 code, the one that every immersive sim still uses to mark itself as part of the tribe to this day, without being accused of sacrilege and blasphemy?

The answer, to the remake's benefit and detriment, is "faithfully". Nightdive's *System Shock* is still very much that game from 1994. It's a project that aims to upgrade, beautify, and smooth down some rough edges. There are a few new additions, but this is no sweeping overhaul, and it leaves most of the best and worst of the original game intact.

REMEMBER CITADEL

System Shock's setup is classic cyberpunk fare. You're a hacker, a future ne'er-do-well who gets caught trying to sneak their way into the servers of the TriOptimum Corporation. In the prologue—a new, semi-playable version of the original game's opening cutscene—you barely make it through the login screen before thugs with guns kick down your door.

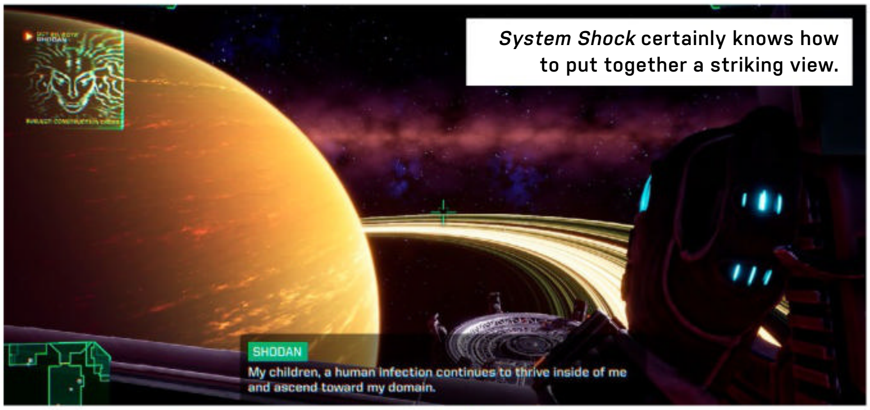
Not to worry, as a corporate executive has an offer: break the ethical restraints on the AI, SHODAN, that runs TriOp's Citadel Station facility near Saturn, and he'll not only let you go; he'll furnish you with the military cybernetics you were trying to steal. You do it. You regret it.

Then the game begins, and the remake's devotion to the original becomes apparent. After a six-month post-surgery convalescence, you awaken in one of Citadel Station's medical bays, an almost one-to-one recreation of the same starting area from the first game. There's the health pack on the shelf to your right, the steep ramp down to the exit and storage closet, and you even have to hit a button next to the closet door to open it, rather than clicking on the door itself.

It feels like Nightdive is trying to convince you that you're in safe hands: I suspect it's exactly what a lot of fans want to see, and honestly? It mostly works.

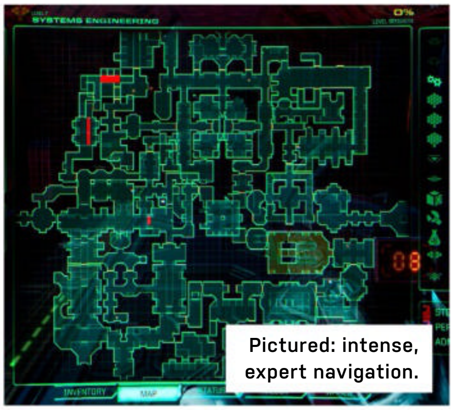
Citadel's hallways are a joy to roam, just as they were in the original, and exploration will reward you with new weapons, cyberware, reserves of your supplies of ammo, or most precious of all, literal trash, which you can exchange for credits at the game's recyclers to buy mods (a new addition for the remake) for your expanding roster of guns.

© PRIME MATTER

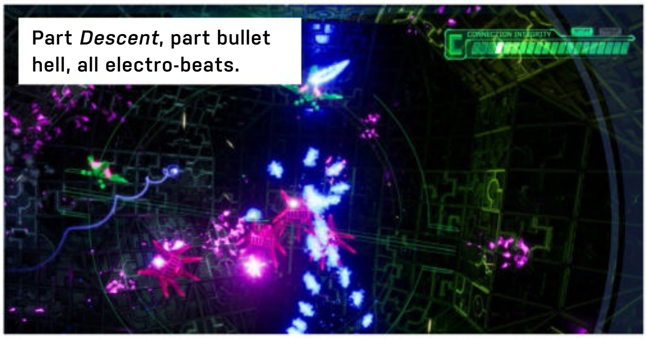


System Shock certainly knows how to put together a striking view.

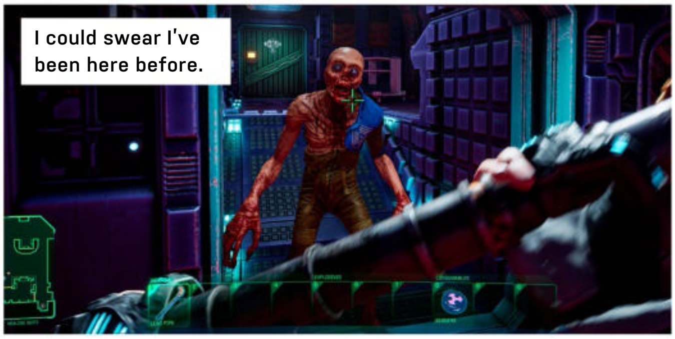
SHODAN
My children, a human infection continues to thrive inside of me and ascend toward my domain.



Pictured: intense, expert navigation.



Part *Descent*, part bullet hell, all electro-beats.



I could swear I've been here before.

That aside, it's still the Citadel Station I remember, but where before the hallways were bright, wobbly, and flat, now they have a fully realized physicality, dark and brooding, made of materials that clang, thud, or ding as shots glance off them.

PUNCHING DECK

The station is only one part of *System Shock*, the other being the tremendously '90s idea of cyberspace. At certain points you run up to a terminal, jack in, and find yourself in an area that shares that newfound sense of space.

It actually makes it feel a fair bit different in this iteration of *System Shock*. In place of the sparse and confusing wireframe of the first game, Nightdive has created a mode that is basically *Descent*. It's colorful and fast-paced, especially compared to the non-cyberspace parts of the game, electronic music blares, and the unrelenting relativity of up and down may have you feeling seasick as you dodge patterns of energy projectiles.

It's not perfect, and sometimes cyberspace combat amounts to holding strafe while keeping your crosshair trained on an enemy that looks disconcertingly like an anthropomorphic octopus. The way the final cyberspace encounter has been dramatically changed is more of a sidegrade than anything, but the studio has done a great job of bringing this segment of the game up to date and simplifying it while keeping its vibes intact. I can't help but wonder what the result would have been if Nightdive had adopted a similar willingness to change things up with the rest of the game.

TEDIOUS ANARCHY

Although it tickles my nostalgia centers, there are downsides to Nightdive's reverence for the first game. Citadel was a maze then, and it's a maze now, a mess of switchbacks, nooks, and crannies.

At first, that makes for fun exploration, but it becomes laborious when you have to repeatedly navigate its mazes. One of the artifacts of the original game's design that Nightdive hasn't changed is a wearying amount of backtracking. Citadel Station is built vertically into nine floors, and no one decided to just build one elevator that goes to every single one.

That means when, for example, the game decides it's time for you to go back to level 3 at the end of level 6, you have to navigate your way to different elevators on each floor in between them, sometimes at opposite poles of twisting areas.

IMMORTAL MACHINE

Years ago, Nightdive's project to remake *System Shock* was put on hold so that the devs could "reassess" their path. They'd suffered mission creep, and strayed too far from their original vision of modernizing the original. Those new ideas ate up an already limited budget and risked angering Kickstarter backers who, more than anything, just wanted a modern recreation of a beloved classic.

Well they got it, and you know what? It's great. This is, I feel confident saying, the definitive way to play *System Shock* in 2023 and beyond, but I can't help but wonder what that other world looks like: the one where Nightdive had the budget and the good will to take a few more risks, make a few more changes, and dramatically reduce the number of times it asked me to make a U-turn.

–JOSHUA WOLENS

VERDICT

8

System Shock

⊞ **SHOCKINGLY GOOD** Faithful remake of a classic; Easier to use interface; The best way to play *System Shock*.

⊟ **SHOCK TREATMENT** Lots of backtracking; Scant quality of life upgrades.

RECOMMENDED SPECS CPU, Core i7-3770/AMD FX-8350. GPU, GTX 970/Radeon R9 290. RAM, 8GB.

$39.99, primematter.gg, M-rated

Google Bard vs ChatGPT

Two AI chatbots, alike in dignity, but which should you use?

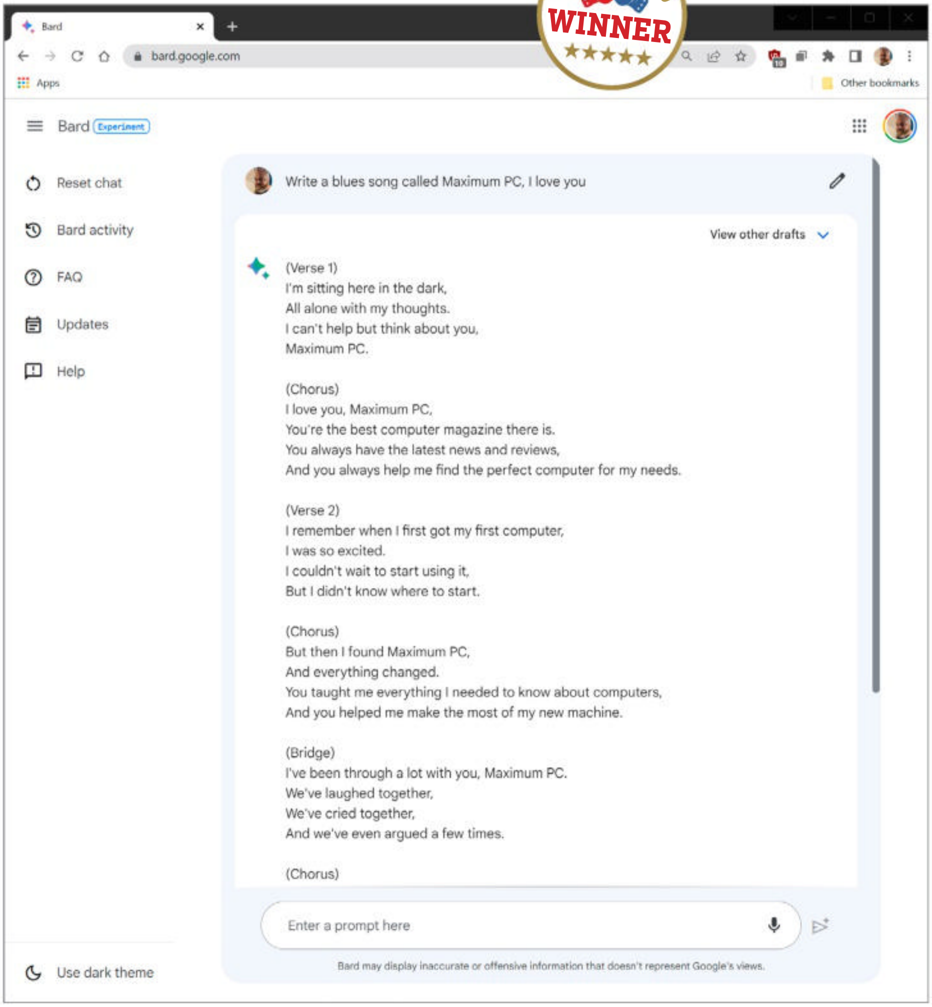
CHATGPT AND BARD are two large language models (LLMs) that are often compared to each other. Both models are capable of generating text, translating languages, writing different kinds of creative content, and answering your questions in an informative way. However, there are some key differences between the two models.

That intro paragraph was written by Google Bard, and while it has a stilted feel to it that's at odds with the sparkling, flowing prose you're used to from *Maximum PC*, it does show that chatbots powered by large language models—which we seem to have decided to call 'AI'—are capable of producing perfectly acceptable text you might think a human had written. Bard and ChatGPT are text-based systems, which means they can't create images like other specialized AIs such as Midjourney or Stable Diffusion.

Even the term 'large language model' itself can be confusing, so let's lay out exactly what it is. LLMs are deep learning neural networks that run on massive racks of GPUs in a data center somewhere. They're trained on huge quantities of text created by humans that is gathered from the wider internet. From this, they learn the relationships between words, and which ones are most likely to come next in a sentence.

From this, we can deduce two things: that they're not aware of what they're doing, and that talking to one is, for all that it might feel natural and spontaneous, essentially having a conversation with an advanced predictive input system like you may use on your phone's keyboard. The skill these models show at responding naturally to questions, or just making conversation, scales with the amount of processing resources and training data you throw at them.

HEAD TO HEAD
WINNER



Write a blues song called Maximum PC, I love you

(Verse 1)
I'm sitting here in the dark,
All alone with my thoughts.
I can't help but think about you,
Maximum PC.

(Chorus)
I love you, Maximum PC,
You're the best computer magazine there is.
You always have the latest news and reviews,
And you always help me find the perfect computer for my needs.

(Verse 2)
I remember when I first got my first computer,
I was so excited.
I couldn't wait to start using it,
But I didn't know where to start.

(Chorus)
But then I found Maximum PC,
And everything changed.
You taught me everything I needed to know about computers,
And you helped me make the most of my new machine.

(Bridge)
I've been through a lot with you, Maximum PC.
We've laughed together,
We've cried together,
And we've even argued a few times.

(Chorus)

Enter a prompt here

Bard may display inaccurate or offensive information that doesn't represent Google's views.

Bard is best thought of as an internet search assistant, but isn't as advanced as ChatGPT.

ChatGPT, from OpenAI, is probably the most famous of the currently available LLMs. Its name combines 'chat' with GPT, or generative pre-trained transformer. This marks it out as a class of LLM trained on huge datasets of unlabeled text and able to generate written responses to the prompts you give. These can be questions or requests to write a song or report.

The current version of ChatGPT available to the public is GPT-3.5, with version 4 kept for a premium service known as ChatGPT Plus. Subscribers get faster response times and priority access to new features. The current crop of LLMs are tuned for conversation using reinforcement learning techniques on top of the unsupervised learning that takes place as the neural network explores its training data.

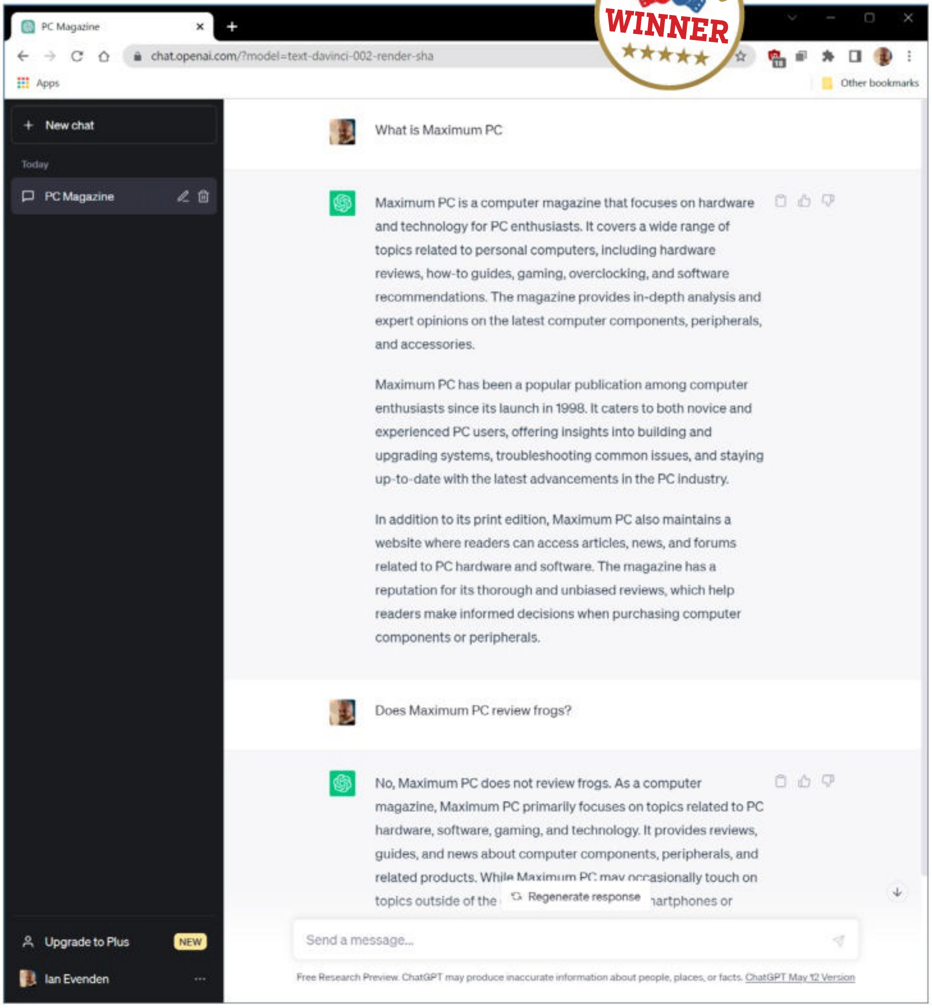
When you use ChatGPT via the OpenAI site today, its limitations become clear. Thanks to incidents in the past where chatbots have developed unpleasant opinions after being exposed to them online, such as the famous case of Microsoft's Tay Twitter bot, chatbots now have guards in place to prevent them from suggesting genocide as an answer to your problems. The bot also has no knowledge of anything that has taken place after its training data was finalized—around June 2020 for GPT-3.5 and September 2021 for GPT-4—though the paid-for bot has the ability to search for newer information. It will tell you this if you ask it for some knowledge outside its training data. Head to chat.openai.com, and you can try it out for yourself.

ChatGPT is extremely versatile, and can write poetry, essays, pitches, and more. It can write code in programming languages such as C or Python (though it won't always run), and can translate and summarize passages of text.

ChatGPT is also accessible through Bing, thanks to a licensing deal between OpenAI and Microsoft that also sees a

© GOOGLE

HEAD TO HEAD
WINNER



What is Maximum PC

Maximum PC is a computer magazine that focuses on hardware and technology for PC enthusiasts. It covers a wide range of topics related to personal computers, including hardware reviews, how-to guides, gaming, overclocking, and software recommendations. The magazine provides in-depth analysis and expert opinions on the latest computer components, peripherals, and accessories.

Maximum PC has been a popular publication among computer enthusiasts since its launch in 1998. It caters to both novice and experienced PC users, offering insights into building and upgrading systems, troubleshooting common issues, and staying up-to-date with the latest advancements in the PC industry.

In addition to its print edition, Maximum PC also maintains a website where readers can access articles, news, and forums related to PC hardware and software. The magazine has a reputation for its thorough and unbiased reviews, which help readers make informed decisions when purchasing computer components or peripherals.

Does Maximum PC review frogs?

No, Maximum PC does not review frogs. As a computer magazine, Maximum PC primarily focuses on topics related to PC hardware, software, gaming, and technology. It provides reviews, guides, and news about computer components, peripherals, and related products. While Maximum PC may occasionally touch on topics outside of the artphones or

Free Research Preview. ChatGPT may produce inaccurate information about people, places, or facts. ChatGPT May 12 Version

ChatGPT offers scarily human-like responses, but isn't up-to-date on current events.

© CHATGPT

Bing plugin available that allows ChatGPT to search the internet using Microsoft's search engine. If you're an Edge user, you'll have noticed that the Bing button on the browser's interface now looks like a speech bubble, and you can use it to ask Bing's chatbot questions. This implementation of ChatGPT acts more like a search engine, however, returning a reply that points you toward sources that could help answer your question, rather than replying directly.

IT'S A BARD-KNOCK LIFE

Bard is Google's entry into this landscape, launched in March 2023 as a response to the success of ChatGPT. The LLM behind it is called PaLM (PaLM 2 was announced in May this year at the Google I/O conference), and uses 540 billion parameters—the variables used in its training. Parameters establish how input data gets transformed into the desired output. For example, the connection weights in an artificial neural network, which determine how likely a word is to be connected to others, are parameters. GPT-4 is reported to have 170 trillion.

There's no subscription version of Bard—for the moment, only the free version is available. You can add Bard to Chrome with an extension from the Chrome Web Store, and it adds a window to your search results, laying out an answer to your question, or a description of the term you searched for, in a naturally written way. You can also integrate ChatGPT into the same window using the extension to get two AI views of a subject.

Alternatively, you can talk to Bard in a chat window just like ChatGPT, though it has a blue 'experiment' logo in the top corner and a disclaimer at the bottom just in case it comes out with something offensive. Bard has a lot of the same capabilities as ChatGPT, including writing computer code or translating and summarizing articles. We found it slightly faster to respond than ChatGPT, but this can change, depending on the number of people trying to use it, and the speed of your internet connection.

A major difference between Bard and ChatGPT is that Bard has access to the internet on top of its training data. If what you're asking about isn't already known, the LLM can top up its knowledge with a Google search—ask both models who won the 2023 Superbowl, and while Bard responds with the Kansas City Chiefs, ChatGPT can't provide an answer. Bard responses have a 'Google it' button, which brings up related search terms so you can take your research further.

Both models are susceptible to hallucination—the tendency of an LLM to make things up, but in such a convincing way you'd swear it was telling the truth. As the chatbots mimic the patterns of human language, but have no understanding of what they're saying, the veracity of their statements needs to be checked by a human rather than being taken as true.

An example of this is when asking an LLM to write computer code. The result needs to be checked by someone familiar with the language used, in case the bot has invented new functions that don't actually exist within the language. Despite this, an OpenAI-powered copilot system is available for GitHub, allowing programmers to hand off repetitive or time-consuming basic tasks to a bot, which turns a text prompt detailing what the coder wants into usable code, often with various iterations that can be cycled through, compared, and either accepted or rejected.

Both LLMs are works in progress, and might have developed new abilities by the time you read this. As computing power and parameter sizes continue to increase, we'll see greater fidelity and have more difficulty separating their responses from real human interactions. These chatbots aren't general artificial intelligence like we see on TV, but instead a very clever game of word association, no matter how convincing they may be. **–IAN EVENDEN**

VERDICT
9

Google Bard

+ SEARCHING Can use internet searches in its responses.

– LURCHING Not as advanced as GPT4.

Bard Free $0.00, http://bard.google.com

VERDICT
9

ChatGPT

+ ROBOT Scarily human-like responses.

– NOBOT Not up to date on the news.

Discord Free $0.00, (ChatGPT Plus $20/month) http://chatgptonline.ai

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Radio Ga Ga
> Builder's Paradise
> Sick of Experts
> Salty Chips

Aural Delights

I was delighted that you guys have started doing audio content again! Do you think you might bring back the No BS Podcast? You could do the same thing you're doing right now, just calling it the No BS Podcast! Have you considered picking up the reins and continuing the YouTube channel? That would be awesome!

–W. Smith

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks so much for your feedback on our "Story of the Build" audio series, the third of which you can find linked on page 17—this time with full video from both myself and Sam! We really like recording these audio features, because often there's a lot to tell about these builds that doesn't make the page—how we choose components, some of the challenges we face, and what we're looking at for the next issue. I'm glad you like these features, and hopefully they add to the experience of the digital magazine.

We've not considered picking up the No BS Podcast, but if that's something readers want us to look into, please let us know! I personally love podcasting and radio in general, so it's something that interests me, but I need to make sure it's something that you really want, so if it is, write in to tell us!

Up The Bracket

I felt I should point out a small glitch in your Intel mid-range build in your Blueprints section: the Intel Core i5-12600 is an LGA 1700 format chip, but the recommended CoolerMaster MASTERLIQUID ML240L RGB v2 does not include a LGA 1700 bracket kit. CoolerMaster is out of the kits, but they do appear to be available from other suppliers, so my fingers are crossed that one shows up here soon. **–K. Gross**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you so much for the heads up on this, and sorry to hear about the troubles you've had sourcing the correct bracket. This is a reminder to always make sure your cooler has a compatible bracket for your chip—online retailers usually list compatibility on the product page, or you can check on the box if you're buying in-store. In the meantime, I've told Sam, who puts together the Blueprints section every issue, so he's aware.

GPU Selection

I think you missed a good opportunity with your cover build in the June 2022 issue (page 16). In your Blueprints section, the Turbo section has an Nvidia/Intel combo costing 50 percent more than the top-end AMD equivalent. I think you should have at least used the RX 7900 XTX GPU in this build, rather than an RTX 4090, so you could compare and see if that 50 percent premium is really worth it!

Also, clearly Phanteks and NZXT saw that Hyte had a good thing so they copied it.. .why not go with the original? But with the Phanteks, which needs to be a floor case, why in the world did they put the IO on the bottom? Seems quite odd to me... **–R. Matlow**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: This is a fair point in terms of the GPU selection, although if you want to compare performance, you could look at the April 2023 cover build, which featured the RX 7900 XT. Not the same top-end card, I know, but an idea of what one of AMD's high-end cards can do.

We are sometimes bound by what hardware we can source at any particular time—I know Sam did try to get the XTX card in for the April build, but it wasn't happening at the time. AMD is releasing more affordable cards now, so we'll hopefully get those in to build with soon, but an XTX build still isn't off the cards.

This also applies to the cases we use—we've been

↘ submit your questions to: editor@maximumpc.com fairly criticized for using lots of NZXT cases over the last year (I know, including this issue), so it was good to get the Phanteks NV7 in for the June issue. Even if, as you say, there's some interesting port placement!

Unleashing Skynet

I agree with C. Lloyd's conclusion (May 2022, page 8) that we should "tread more carefully", and that listening to more learned individuals (experts) is a good idea. However, "the world's most influential technology experts" may not have answers that we need to hear. Experts, such as Elon Musk and fellow "most revered AI researchers and developers" have an interest in promoting AI, not hindering it.

Examples: The autonomous vehicle and Microsoft's loss of its "entire ethical team". Who is listening to whom? AI is moving beyond the trivial, into more deeply social, political and scientific realms. In addition, Hinton, 'the Godfather of AI,' and a fellow Canadian, believes AI may pose a profound risk to humanity, but there is a race on to deploy it that may make it unstoppable.

I also read with great interest Jeremy Laird's feature on "How TSMC Came to Rule the World" in the November 2022 issue. I believe we here in Canada have a more dispassionate view on the subject, as it relates to political and economic questions raised by the article.

For example, is lack of innovation (ie. difficulties with 3nm technology) due to insularization, such as a lack of exposure to newer technologies and Western ways of thinking, and/or 'fear' of China? What of your country's CHIPS and Science Act, passed with bi-paritisanship? Is its near- to long-term future in doubt?

A pause no doubt would prove appropriate. We can only hope! **–M. McCullough**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you for your letter, and I am sure there are lots of people who feel the same fears you do. I usually don't like scaremongering, but the amount of headlines that are coming out at the moment do make me feel apprehensive about the future—just one from the day I'm writing this is: "Artificial intelligence is similar extinction risk as nuclear war and pandemics".

I think right now, as impressive as AI is, it's good at helping automate tasks, write summaries, and act as a computerized assistant—anyone who's used them can see the limitations (speaking of which, check out ChatGPT vs Bard on page 92 of this issue). But we can see the pace of improvement in this area moving incredibly quickly, so there feels like a need for some sort of regulation going forward. Whatever happens, we'll be sure to cover the latest developments in our news section each month.

In regards to TSMC, I'm glad you enjoyed Jeremy's article. As well as a love of technology, I also have a great interest in the business side of things, especially as it relates to global supply. I won't speak of China and Taiwan's delicate relationship, as it relates to the countries' political interests, as that's not something I'm qualified on, but I can see the dependance the world has on Taiwan's ability to manufacture and export technology, which is why I'm hopeful that more companies will follow Intel and work on bringing manufacturing to the USA and other countries around the world. Whether these fabrication plants will make it on schedule over the coming years, or have the technical capabilities to match the likes of TSMC in the short-term, remains to be seen.

Virtual Insanity

I am now one month away from being 55 years old. In October 2021, during COVID, my wife and I purchased Quest 2 VR headsets for ourselves and my wife's parents so we could do things together during the holidays.

In May of 2022, I then bought my first ever pre-built gaming PC in order to play PC VR titles. Since then, I've grown fascinated by the components, how PCs work, upgrading, building, new technology, etc.

Ignorance has led me to multiple videos and articles on gaming PCs, and I read *Maximum PC*, but while I am growing in knowledge, many things are still way over my head.

I'm wondering if you or one of your staff would be so kind as to possibly suggest a book or source which would help me come a little bit more up to speed, please. **–T. Gillis**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Well, I hope you can forgive me for the shameless plug, but a *Maximum PC* subscription now comes with access to our digital archive, which has hundreds of issues with archives of features, how-tos, and reviews that should help.

Failing that, head to pcgamer.com/hardware for everything hardware-related on building and upgrading your PC. If video is more your thing, look at youtube.com/@pcgamer for similar guides and instructional videos, as well as videos covering VR and gaming. If you bought your pre-built PC a year ago then you should be ok for now, but there are new headsets coming out that might be worth looking at, including a just-announced new model from Oculus.

Data Driven

Is there any chance you guys would have an interest in revisiting the "Number Crunching Monster" data scientist rig build that was published in your October 2020 issue on page 20? I'm the guy who had suggested that piece to [previous editor] Zak (you can find my Letter to the Editor and Zak's response on p.81 of the September 2020 issue). Aside from the fact that a lot has changed in two years, readers never got a follow-up regarding the memory issues Christian described from the build.

Anyhow, despite the minor disappointment with the memory, that was a great build! Other data scientist colleagues of mine agreed. I'd love to see your revised-for-2023 take on how to approach it, especially now that GPU prices seem to be settling down a bit.

Thanks a bunch!

–V. Thompson

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Yeah, I love the idea of different themed builds, and while a data scientist rig might have limited appeal to the overall Maximum PC audience, I'm sure plenty of people will be interested in its wider uses, perhaps on AI-based applications. I've also been out and about seeing new pre-built machines for this market from the likes of HP and Lenovo, which suggests there's a real market for these workstation -style PCs.

If anyone has any other suggestions for themed builds, please do get in touch and let us know what you'd like to see!

THE BUILDS

THIS MONTH'S STREET PRICES...

BUDGET

OUT OF ALL THE BUILDS, the budget models may be seen as the least exciting, but we enjoy trying to crunch down the prices here while keeping these machines current. In the last issue, for the Intel machine, we introduced a new motherboard, ASRock B660M-HDV Micro ATX. As it still costs $95, we've decided to keep this in place, as it's a great little mobo that supports the rest of the machine comfortably with its LGA1700 socket, plus up to 128GB of DDR4 RAM (still perfectly fine for a budget machine).

Speaking of RAM, we've upgraded this for an extra $5, taking our speeds from 3200MHz to 3600MHz. This is the same PNY XLR8 Gaming EPIC-X RGB 16 GB Kit—just a slightly faster model. For the price of a nondescript overinflated iced coffee, this isn't a bad upgrade. The Intel and AMD machines contained the same previous sticks of RAM, so we've made the same change on both systems. As for our CPU/GPU combo, we're happy to keep the Intel Core i3-13100F and Intel Arc A750 8GB. Although the CPU has increased by $10, our GPU decreased in price by $20, so it more than evens out. As for the rest of the machine, pricing didn't alter too much, so we kept the backbones of the machine the same. With all the small price changes, our build increases this month, but only by a tiny $12 to $778.

Swapping over to the AMD budget build, we're sticking with the AMD Ryzen 5 5600, although later down the line, if we can make some more savings, we'll upgrade this to the Ryzen 5 5600X model. It's only an extra $30, so value builders should be aware of this. Our only change, other than the RAM, was to save further money by swapping GPUs. Our last card, the ASRock Phantom Gaming D OC Radeon RX 6500 XT 4GB, was $165, but now that's increased back to $180. We found another similar 6500XT card, the ASRock RX6500XT CLI 4G to replace it, as that is $160. These changes raised our total cost from $732 to $742.

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W Corsair CV450 80+ Bronze	$59
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard	$119
CPU	AMD Ryzen 5 5600	$130
GPU	ASRock RX6500XT CLI 4G Radeon RX 6500 XT 4GB **NEW**	$160
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3600MHz **NEW**	$50
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$47
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $742

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W Corsair CV450 80+ Bronze	$59
Mobo	ASRock B660M Pro RS Micro ATX GA1700	$95
CPU	Intel Core i3-13100F	$120
GPU	Intel Limited Edition Arc A750 8GB	$230
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3600MHz **NEW**	$50
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$47
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $778

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TAKE IT FROM A GEEK.℠

AN ISSUE THAT MAINLY AFFECTED our Intel mid-range build that we were unaware of arose thanks to a helpful reader (see Comments, page 94). Our previous CPU cooler for both machines, the Cooler Master MASTERLIQUID ML240L RGB V2, didn't contain an LGA1700 bracket in the box. To avoid this issue, we swapped out both coolers on the Intel and AMD builds for an MSI model we know contains both AMD AM5 and Intel LGA1700 brackets. The MSI MAG CORELIQUID 240R V2 costs $20 more, but is worth it. It's a great cooler for the price, featuring a rotatable blockhead, full ARGB lighting via MSI Mystic Light, and a 240ml radiator with a split pathway running down it to help dissipate heat quicker.

CPU-wise, the Intel Core i5-12600KF gets replaced with the Intel Core i5-12600K with integrated Intel UHD Graphics 770. This is listed for $225, which is the same price as the F model, so it makes sense to go for the better option. Our biggest change for the mid-range Intel PC has to be the GPU, though. We've finally made the switch from a 30 series to a 40 series Nvidia card with the Gigabyte EAGLE GeForce RTX 4060 Ti 8 GB Video Card at $10 less than the Gigabyte EAGLE OC 3060 Ti card. We're getting a much more efficient and powerful card. The Intel machine's final price goes up from $1,399 to $1,407—for a new series GPU, better CPU, and a better CPU cooler, that's a pretty good deal.

Onto the mid-range AMD build, this also gets the CPU cooler change to the MSI MAG CORELIQUID 240R V2. We're also upgrading the CPU for a very similar but slightly better model. We're going from the AMD Ryzen 5 7600 to the AMD Ryzen 5 7600X. Both offer the same six Zen 4 cores and 38MB of cache—it's just the 7600X has a higher base clock of 4.7GHz compared to the 7600, which has a base clock of 3.8GHz. The AMD mid-range build was $1,392 last time, but has gone up slightly to $1,442—not terrible for a CPU and CPU cooler upgrade.

AMD INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$130
PSU	750W EVGA 750 BP 80+ Bronze		$90
Mobo	ASRock B650M PG RIPTIDE Wi-Fi Micro ATX AM5		$215
CPU	AMD Ryzen 5 7600X	NEW	$240
Cooler	MSI MAG CORELIQUID 240R V2	NEW	$110
GPU	Gigabyte Radeon RX 6750 XT Gaming OC 12GB		$400
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz		$105
SSD	1TB Crucial P5 Plus NVME M.2 PCIe 4.0		$70
HDD	2TB Seagate Barracuda Compute 7200		$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,442**

INTEL INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$130
PSU	750W EVGA 750 BP 80+ Bronze		$90
Mobo	Gigabyte Z790 UD AC ATX LGA 1700		$195
CPU	Intel Core i5-12600K	NEW	$225
Cooler	MSI MAG CORELIQUID 240R V2	NEW	$110
GPU	Gigabyte GeForce RTX 4060 Ti EAGLE 8GB	NEW	$400
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz		$105
SSD	1TB Corsair MP600 PRO NH M.2 PCIe 4.0		$70
HDD	2TB Seagate Barracuda Compute 7200		$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,407**

TURBO

WE HAVE THE most fun with our virtual PC spending money when have freedom to go all-out, and that's with our Turbo machines. As the name implies, these are the fastest of the bunch. Last issue, we brought in arguably one of the best gaming chips on the market on the AMD side, the AMD Ryzen 9 7950X3D. We used this rocketship of a CPU in our build last issue, and it certainly impressed us. It's not the cheapest CPU, costing nearly the entirety of the AMD budget machine, but hey, that's the whole point of the Turbo builds, right? Well, compared to last time, we actually saved a $10 on this CPU, so it's a small win nonetheless.

As with the CPU, we've stuck with the same GPU, the ASRock Phantom Gaming OC Radeon RX 7900 XTX 24GB. This also saw a $10 price drop, so we can't complain. It's currently one of the best Ryzen GPUs as well, so pairs fantastically with our Ryzen 9 7950X3D chip. To keep the CPU cool, we're introducing the new NZXT cooler that we used in this issue's build. This is the NZXT Kraken Elite 360 RGB. It now features a refreshed 60Hz display, which we used to showcase our CPU and GPU temps. You can add your custom imagery and GIFs here, too. With this cooler, we were still slightly under the $3,000 mark at $2,989.

The NZXT Kraken Elite 360 RGB also made its way to the Intel Turbo build, replacing the older version of the cooler. Last time, we also brought in a new PSU, but we are already swapping that 1000W Corsair RM1000X 80+ Gold out for the new Corsair PSU we used in the main build for this issue. We got our hands on the new Shift variant, featuring ATX 3.0, and a new cable perfect for the new 40 series GPUs that bypasses the need for the dreaded GPU PCIe splitter. It also features side access for the PSU cables, which makes life 1000X easier—see what we did there?

Aside from those swaps, we kept the rest of the build the same. With an Intel Core i9-13900K and a Zotac GAMING Trinity OC RTX 4090 card, we can't complain about the performance we're getting. Our total price tag went from $3,365 to $3,373. It's mainly due to our upgraded CPU cooler, although we did also see a drop of $70 on our 13900K!

AMD INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	1000W NZXT C1000 80+ Gold	$180
Mobo	ASRock X670E PG Lightning ATX AM5	$260
CPU	AMD Ryzen 9 7950X3D	$690
Cooler	NZXT Kraken X73 Elite RGB 360mm **NEW**	$300
GPU	ASRock Phantom Gaming OC Radeon RX 7900 XTX 24GB	$980
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$180
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$77
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,989**

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	1000W Corsair RM1000x Shift 80+ Gold **NEW**	$210
Mobo	Gigabyte Z790 UD AC ATX LGA 1700	$195
CPU	Intel Core i9-13900K	$500
Cooler	NZXT Kraken X73 Elite RGB 360mm **NEW**	$300
GPU	Zotac GeForce RTX 4090 GAMING Trinity OC 24GB	$1,589
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$180
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$77
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$3,373**

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